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A GENERALIZED THEORY OF THE EFFECTS OF TARIFFS ON THE TERMS OF TRADE[1]

By J. BHAGWATI *and* H. G. JOHNSON

TRADITIONAL analysis of the effect of a tariff on the terms of trade of the protecting country draws a distinction between two cases: (1) where the tariff revenue is spent by the government; and (2) where the tariff revenue is redistributed as an income subsidy to the private sector. In both cases the conclusion reached is that the terms of trade of the protecting country will improve or deteriorate according as the country's elasticity of demand for imports is greater or less than the marginal propensity to consume importables (of the government or the private sector, as the case may be). By splitting the elasticity of demand for imports into the sum of the compensated elasticity of demand for imports and the private sector's marginal propensity to consume importables, it can further be shown (on the usual assumption of convex indifference and transformation curves) that the terms of trade must improve if the private sector spends the tariff revenue; and that, if the government spends the tariff revenue, the terms of trade can only deteriorate if the government's marginal propensity to consume importables exceeds the private sector's marginal propensity to consume importables by more than the private compensated elasticity of demand for imports. Normally, the terms of trade will not improve sufficiently to offset the effect of the tariff in raising the domestic price of importables; but the tariff will reduce the domestic price of importables if the marginal propensity to consume exportables of whichever sector spends the tariff revenue is greater than the foreign elasticity of demand for exportables.

This analysis, however, is founded on four restrictive postulates:

(1) *Initial free trade.* It is assumed that there is no tariff in effect in the initial situation; hence the analysis does not apply to the case of an increase in an existing tariff rate.

(2) *Independence of consumer taste and government expenditure.* Where the government spends the tariff revenue, it is assumed that the amount of government expenditure—either the total, or the amount spent on particular commodities—does not affect the way in which the private sector divides its expenditure between importables and exportables; hence the

[1] The major part of the work on this paper was done at the University of Chicago; the final draft was prepared at the Institute for Economic Research, Queen's University, Kingston, Ontario. We are grateful to the Institute for extending to us the use of its facilities.

analysis does not apply to the case of dependence of consumer taste on the amount of government expenditure.

(3) *Aggregation of the private sector.* It is assumed that the private sector can be treated as a homogeneous unit with respect to its demand for imports; this ignores the effects of a change in the domestic price of importables in redistributing real income (*a*) between consumers with different tastes, and (*b*) between owners of different collections of factors of production, as well as the influence (in case (2)) of the way in which the redistributed tariff revenue is allocated among private consumers.

(4) *Inelastic supply of factors.* In dealing with the effects of a change in the domestic price of importables on domestic production, it is assumed that the supply of resources is given; hence the analysis does not take account of the effects on import demand of changes in factor supplies consequential on the change in the tariff rate.

In this paper we generalize the theory of tariffs by examining the effect of an increase in the tariff rate when these restrictive assumptions do not hold.[1] We distinguish three major cases: (1) where the government spends the tariff revenue and private demand is independent of government expenditure; (2) where the proceeds of the tariff are consumed by the private sector; (3) where the government spends the tariff revenue and the amount of government expenditure influences the private sector's demand for imports. Section I analyses the first two (the traditional) cases, abandoning the restriction of initial free trade. Section II analyses the third case, abandoning the second restriction of independence of private demand and government expenditure. Section III abandons the third restriction and incorporates the effects of disaggregating consumption demand and factor ownership in the analysis of the three cases. Section IV abandons the fourth restriction and extends the analysis to include the effects of variable supplies of factors. These four sections are concerned with the effect of the tariff increase on the terms of trade; in Section V we analyse the effect of the tariff increase on the domestic price of importables.

Throughout the analysis we assume that only two goods are produced and consumed, 'exportables' and 'importables'; in analysing case (3),

[1] For the traditional analysis, reference may be made to A. P. Lerner, 'The Symmetry Between Import and Export Taxes,' *Economica*, N.S., vol. iii, no. 11 (Aug. 1936), pp. 306–13; L. Metzler, 'Tariffs, the Terms of Trade and the Distribution of National Income', *Journal of Political Economy*, vol. lvii, no. 1 (Feb. 1949), pp. 1–29; and R. E. Baldwin, 'The Effect of Tariffs on International and Domestic Prices', *Quarterly Journal of Economics*, vol. lxxiv, no. 1 (Feb. 1960), pp. 65–78. In a later supplement to his classic paper, op. cit., Lloyd Metzler recognized explicitly the dependence of the analysis developed by him, of the effect of tariffs on domestic prices, on the assumption of initial free trade; see his 'Tariffs, International Demand, and Domestic Prices', *Journal of Political Economy*, vol. lvii, no. 4 (Aug. 1949), pp. 345–51.

however, we assume that the amount of government expenditure enters consumers' utility functions as a third consumption good. In dropping restrictions (3) and (4) we assume that income is shared between two individuals, each of whom owns a collection of productive factors and earns an income from the sale of their services; and that each good is produced in a linear homogeneous production function employing two factors, labour and capital, whose earnings are wages and rent respectively, these factors being employed in different ratios in the two industries. Markets for goods and factors are assumed to be perfectly competitive. In analysing the effect of the tariff increase in the various cases, we employ the simplifying device of assuming the conditions for stability in the international market; this permits the effect of the tariff on the terms of trade to be inferred from its effect on the excess demand for imports at the initial terms of trade, and its effect on the domestic price of importables to be inferred from its effect on the excess demand for imports at the initial domestic price of imports.

We employ the following mathematical symbols throughout the article; other symbols are defined when they appear in the argument:

p, the international price of the importable good in terms of the exportable good (the terms of trade); by choice of units, p is initially made equal to unity;

t, the tariff rate, defined as a proportion of the international price of importables;

π, the domestic price of importables in terms of exportables; $\pi = (1+t)p$; because p is initially unity $d\pi/dt$ in the mathematical development below is equal to unity;

P, the quantity of importables produced domestically;

Q, the quantity of exportables produced domestically;

Y, the amount of earned income: $Y = \pi P+Q$;

C, the quantity of importables consumed out of private income; private income is equal to earned income where the government spends the tariff revenue (cases (1) and (3)), and to earned income plus tariff proceeds where the latter are redistributed to the private sector (case (2));

M_1, the quantity of importables imported for private consumption: $M_1 = C-P$;

M_2, the quantity of importables consumed by the government out of tariff revenue; this quantity must obviously be imported, and it simplifies matters to assume that the government buys its importables abroad at the world market price;

M, the total quantity of imports: $M = M_1+M_2$;

R, the tariff revenue: $R = tpM_1$;

c, the private sector's marginal propensity to spend on importables at the domestic price of importables; the private sector's marginal propensity to consume importables is c/π;

g, the government's marginal propensity to spend tariff revenue on imports at the international price of imports; the government's marginal propensity to consume imports is $g/p = g$;

ξ, the domestic price elasticity of private demand for imports, tariff revenue being held constant where it affects private demand [cases (2) and (3)]; $\xi = -\frac{\pi}{M_1}\frac{\delta M_1}{\delta \pi}$;

η, the price elasticity of private demand for importables, earned income and tariff revenue being held constant; $\eta = -\frac{\pi}{C}\frac{\delta C}{\delta \pi}$;

η', the compensated elasticity of private demand for importables; $\eta' = \eta - c$;

ϵ, the elasticity of domestic supply of importables with given supplies of factors of production; $\epsilon = \frac{\pi}{P}\frac{\delta P}{\delta \pi}$;

ξ', the compensated elasticity of private demand for imports:

$$\xi' = \frac{C}{M_1}\eta' + \frac{P}{M_1}\epsilon = \xi - c.$$

Barred symbols denote initial magnitudes of the variables when these might be confused with the functional relationships that determine them. The main equations in the mathematical argument have been numbered; the formulae derived have also been assigned roman numerals.

I. The Effect of an Increase in the Tariff on the Terms of Trade: cases (1) and (2)

An increase in the tariff rate will cause an improvement or a deterioration in the terms of trade according as it gives rise to a negative or a positive world excess demand for importables at the initial international price of imports. Since the quantity of imports supplied by the rest of the world at the initial terms of trade is unchanged by the increase in the tariff, the change in the world excess demand for importables resulting from the tariff increase is equal to the change in the tariff-increasing country's demand for imports. On the usual assumptions that the private sector can be treated as an aggregate and that factor supplies are inelastic, this change, in cases (1) and (2), is the net result of two effects of the tariff increase:

(i) the effect of the increase in the domestic price of importables due to the tariff increase on the quantity of imports privately demanded;

(ii) the effect of the change in the amount of tariff revenue due to the

increase in the tariff and the consequential change in the quantity of imports privately demanded under (1) above, on the quantity of imports demanded by the government or the private sector, whichever spends the tariff revenue.

(1) The change in the quantity of imports privately demanded is determined by the elasticity of private demand for imports; this change, which we denote by $\delta M_1/\delta t$ because the tariff increase also affects private demand for imports in other ways in case (2) and other cases considered below, is:

$$\frac{\delta M_1}{\delta t} = \frac{\delta M_1}{\delta \pi}\frac{d\pi}{dt} = -\frac{\overline{M}_1}{\pi}\xi.$$

The change in the quantity of imports demanded due to the increase in the domestic price of importables is actually the net result of three effects of the increase in the domestic price of importables:

(i) the change in private consumption of importables due to the increase in the price of importables, determined by the price elasticity of private demand for importables; this change is:

$$\frac{\delta C}{\delta \pi}\frac{d\pi}{dt} = -\frac{\overline{C}}{\pi}\eta;$$

(ii) the change in private consumption of importables due to the increase in income earned in domestic production resulting from the increased domestic price of importables, determined[1] by the initial amount of domestic production of importables and the marginal propensity to consume importables; this change is:

$$\frac{\delta C}{\delta Y}\frac{\delta Y}{\delta \pi}\frac{d\pi}{dt} = \frac{c}{\pi}\overline{P};$$

(iii) the increase in domestic production of importables in response to the increase in their domestic price, determined by the elasticity of domestic supply of importables; this change is:

$$\frac{dP}{d\pi}\frac{d\pi}{dt} = \frac{\overline{P}}{\pi}\epsilon.$$

The net result of these three effects is:

$$\begin{aligned}\frac{\delta M_1}{\delta t} &= -\frac{\overline{M}_1}{\pi}\left(\frac{\overline{C}}{\overline{M}_1}\eta - \frac{\overline{P}}{\overline{M}_1}c + \frac{\overline{P}}{\overline{M}_1}\epsilon\right)\\ &= -\frac{\overline{M}_1}{\pi}\left(\frac{\overline{C}}{\overline{M}_1}\eta' + \frac{\overline{P}}{\overline{M}_1}\epsilon + c\right)\\ &= -\frac{\overline{M}_1}{\pi}(\xi' + c). \qquad (1)\end{aligned}$$

[1] The effect on the value of output of the increase in production of importables (analysed under (iii) above) and the associated reduction in the production of exportables induced by the increase in the domestic price of importables can be ignored, since maximization of the value of output under competition implies that the effect of small departures of production from the equilibrium quantities is of the second order of smalls.

(2) (*a*) Where the government spends the tariff revenue, the change in the quantity of imports it demands will be determined by the change in the tariff revenue from private imports and the government's marginal propensity to consume importables; this change is:

$$\frac{dM_2}{dt} = g\frac{dR}{dt} = g\left(t\frac{\partial M_1}{\partial t} + \bar{M}_1\right) = g\bar{M}_1\left(1-\frac{t}{\pi}\xi\right). \qquad (2\,a)$$

(*b*) Where the tariff revenue is redistributed to the private sector the change in the quantity of imports privately demanded will be determined by the change in the tariff revenue and the marginal propensity to consume importables of the private sector; but the change in the tariff revenue in this case is not simply the change in tariff revenue due to the change in private imports analysed under (1) above, but the product of that change and the sum of a series which is determined by the marginal propensity to consume imports of the private sector. The initial change in the tariff revenue due to the increase in the tariff rate and its effect on the quantity of imports privately demanded will change private expenditure on imports by a fraction of itself approximately equal to c, of which c/π will represent a change in the quantity of imports demanded and ct/π a further change in tariff revenue, which will lead to further changes of c^2t/π^2 in the quantity of imports demanded and c^2t^2/π^2 in tariff revenue, and so on. Hence the total change in redistributed tariff revenue will be:

$$\frac{dR}{dt} = \left(1+\frac{ct}{\pi}+\frac{c^2t^2}{\pi^2}+\ldots\right)\frac{\delta R}{\delta t} = \frac{\pi}{1+(1-c)t}\frac{\delta R}{\delta t},$$

where

$$\frac{\partial R}{\partial t} = \frac{\delta}{\delta t}(tM_1) = \bar{M}_1\left(1-\frac{t}{\pi}\xi\right);$$

and the change in the quantity of imports demanded due to the effect of the tariff change on the amount of redistributed tariff revenue will be:

$$\frac{\partial C}{\partial R}\frac{dR}{dt} = \frac{c}{\pi}\frac{\pi}{1+(1-c)t}\frac{\partial R}{\partial t} = \frac{c\bar{M}_1}{1+(1-c)t}\left(1-\frac{t}{\pi}\xi\right). \qquad (2\,b)$$

In *case* (*1*) the total effect of the tariff increase on the world excess demand for importables is [the sum of equations (1) and (2 a)]:[1]

$$\begin{aligned}\frac{dM}{dt} &= -\frac{\bar{M}_1}{\pi}\xi + g\bar{M}_1\left(1-\frac{t}{\pi}\xi\right)\\ &= \bar{M}_1\left(g-\frac{1+gt}{\pi}\xi\right)\\ &= \bar{M}_1\left(g-(1+gt)\frac{c}{\pi}-\frac{1+gt}{\pi}\xi'\right). \qquad (3)\,\mathrm{I}\end{aligned}$$

[1] This result can be obtained directly by differentiating the basic equation for this case. $M \equiv M_1+M_2 = M_1(\pi)+M_2(R)$, where $R = tM_1$ and $dM_2/dR = g$.

If initially there is free trade, this reduces to $dM/dt = \bar{M}_1(g-c-\xi')$, which yields the traditional conclusion that world excess demand for importables at the initial world price will be negative and the terms of trade turn in the country's favour unless the government's marginal propensity to consume importables exceeds the private sector's marginal propensity to consume importables by more than the private sector's compensated elasticity of demand for imports. This in turn requires that the government have a stronger marginal preference for importables than the private sector (a higher marginal propensity to spend on them at the same price) and that the private compensated elasticity of demand for imports be less than unity (assuming that imports are not inferior in private consumption, and that the government, having no initial revenue, cannot have a marginal propensity to spend on importables greater than unity). *If there is a tariff in effect, it remains true that the government must have a higher marginal propensity to consume importables than the private sector for the terms of trade to deteriorate; but since the tariff makes the real cost of importables to the consumer higher than to the government* (assuming that the latter chooses rationally on the basis of world and not domestic prices), *this does not necessarily imply that the government has the stronger marginal preference for importables* (in the sense defined above). *In the general case, also, the terms of trade can deteriorate even if the private compensated elasticity of demand for imports exceeds unity*; this could occur if the government's marginal propensity to consume importables (though higher than the private) were sufficiently low or the tariff rate sufficiently high to offset a compensated elasticity above unity, or if importables were inferior goods to the government at the income level represented by the initial tariff revenue.

In *case (2)* the total effect of the tariff increase on the world excess demand for importables is [the sum of equations (1) and (2 b)]:[1]

$$\begin{aligned}\frac{dM}{dt} &= -\frac{\bar{M}_1}{\pi}\xi + \frac{c\bar{M}_1}{1+(1-c)t}\left(1-\frac{t}{\pi}\xi\right)\\ &= \frac{\bar{M}_1}{1+(1-c)t}(c-\xi)\\ &= -\frac{\bar{M}_1\xi'}{1+(1-c)t}. \qquad \text{(4) II}\end{aligned}$$

It follows that world excess demand for importables at the initial world price must be negative and the terms of trade must be improved following an increase in the tariff rate; hence *the result of a tariff increase in case (2) is the same, whether the tariff increase is imposed on an initial free-trade situation*

[1] This result can be obtained directly by differentiating the basic equation for this case, $M \equiv M_1 = M_1(\pi, R)$ where $\delta M_1/\delta R = c/1+t$ and $R = tM_1$.

or on an existing tariff. This is only what one would expect, since redistribution of tariff proceeds reduces the effect of a tariff increase on the demand for imports to a pure substitution effect.

II. The Effect of an Increase in the Tariff on the Terms of Trade: case (3), Dependence

In the preceding section we have analysed the two traditional cases, (1) where the government spends the tariff revenue, and (2) where the tariff revenue is redistributed to the private sector. In analysing the latter case we have assumed that the tariff proceeds are redistributed in the form of an income subsidy, which is spent by the private sector in the same way as would be an increment in earned income.[1] But it would make no difference to the final result if it were assumed that the tariff proceeds were distributed in kind instead of in cash—that the government used the tariff revenue to purchase some collection of exportables and importables and distributed that collection to the public. For the public would merely adjust its purchases from its earned income to obtain the same total consumption of each good as it would have chosen if the tariff proceeds had been redistributed in cash. A subsidy in kind can only produce a different consumption pattern than a cash subsidy if the amount of a particular good distributed in kind is larger than the total that would have been purchased out of the subsidy-recipient's own income plus the cash subsidy, and this possibility is excluded in the present case by the fact that the amount of goods the government can distribute in kind is restricted by the amount of tariff proceeds it collects.

In analysing the former case we have made the traditional assumption that the behaviour of the private sector is unaffected by the expenditure of the tariff revenue by the government—that private-sector tastes are independent of government consumption. The case of dependence of private tastes on government consumption has recently been examined by Robert Baldwin, who reaches the rather surprising conclusion that the results in the dependence case are the same as in the income-subsidy case. This conclusion is understandable, however, once it is realized that Baldwin identifies the general case of dependence with the special case in which consumers regard government purchases as equivalent to an addition to their own private consumption of the goods concerned. In fact, in his theoretical analysis, Baldwin explicitly treats government consumption as the provision of benefits in kind to consumers, which means that the government in effect is not consuming the tariff proceeds on its own behalf but is redistributing them in kind; and, as we have just argued,

[1] This income-subsidy assumption is to be found in J. E. Meade, *A Geometry of International Trade* (London: Allen & Unwin, 1952), chap. vi. Metzler, *op. cit.*, assumes, however, a reduction in an existing income tax by this amount, which reduces to the same thing.

this should have the same effect as redistributing them through income subsidies.[1]

The more interesting general problem of dependence arises when the government uses the tariff proceeds for its own consumption, *and* the amount of some or all of the governmental services provided by this consumption influences the relative quantities of commodities purchased by the private sector from its earned income in a way not necessarily identifiable with the influence of a direct governmental subsidy in cash or kind. This is a more realistic case than that traditionally analysed [our case (1)] and a more general case than that analysed by Baldwin. One would expect that an increase in state expenditure on, say, police services would lead to a reduction in the amount of private expenditure on fire-arms, locks and bolts, and bodyguards, but not that the effects of the two changes on demand would exactly offset one another, since the government provides services in a different form than they would be privately provided. Similarly, the government provides collective goods which would not be privately provided if consumers had the spending of their tax contributions, and which influence the pattern of private demand.

Technically, dependence implies that the amount of some or all of the service provided by government enters the utility function of the private sector in a significant way (i.e. its substitute-complement relationship with commodities privately consumed varies between commodities) so that the private sector's demands for goods become functions of the total or of some component of the amount of government consumption. In so far as the composition of governmental services depends on the relative prices of commodities purchased by the government, the equilibrium of the economy will vary with the nature of the dependence of private demands on the amounts of governmental services provided; but for the present analysis, which is concerned with the effect of a tariff increase on the excess demand for importables at the given initial world price of importables and assumes that the government chooses on the basis of this price, private demands can be assumed to depend only on the total amount of governmental expenditure, since this will determine the amounts of the separate types of government service provided.[2]

[1] R. E. Baldwin, op. cit., especially pp. 69–71. In note 5 to p. 67, Baldwin interprets 'dependence' in the broader sense in which we discuss it: 'However, as long as the consumption by the government furnishes some utility to the private sector, it is possible for this public consumption to change the civilian offer curve of exports for imports.' But in his analysis he gives it the narrow interpretation discussed here. We are indebted to Mr. Baldwin for correspondence and personal discussion which removed a misunderstanding of his argument on our part.

[2] Our problem here is analytically similar to that faced by J. R. Hicks in his analysis of the effects of a change in wants, in chap. xvii, especially pp. 162–4, of *A Revision of Demand Theory* (Oxford: At the Clarendon Press, 1956).

Dependence means that, in addition to the price effect on private demand for imports and the revenue effect on governmental demand for imports analysed under case (1), the tariff increase will have a dependence effect on private demand for imports through its effect on the amount of government revenue and consumption. This effect will be:

$$\frac{\delta C}{\delta R}\frac{dR}{dt} = \frac{b}{\pi}\left(t\frac{dM_1}{dt}+\bar{M}_1\right), \tag{5}$$

where b, the change in private expenditure on importables associated with a unit change in government expenditure, will be positive or negative according as imports are complementary or substitutary with government expenditure in private consumption. The total change in private demand for imports is now [the sum of equations (1) and (5)]:

$$\frac{dM_1}{dt} = -\frac{\bar{M}_1}{\pi}\xi+\frac{b}{\pi}\left(t\frac{dM_1}{dt}+\bar{M}_1\right) = \frac{(b-\xi)\bar{M}_1}{1+(1-b)t}, \tag{6}$$

and the resulting change in government demand for imports is:

$$\frac{dM_2}{dt} = g\left(\frac{t(b-\xi)\bar{M}_1}{1+(1-b)t}+\bar{M}_1\right) = \frac{(\pi-t\xi)g}{1+(1-b)t}\bar{M}_1; \tag{7}$$

hence the total change in world excess demand for importables is [the sum of equations (6) and (7)]:[1]

$$\begin{aligned}\frac{dM}{dt} &= \frac{\bar{M}_1}{1+(1-b)t}\{b+g\pi-(1+gt)\xi\}\\ &= \frac{\bar{M}_1}{1+(1-b)t}\{b+g\pi-(1+gt)c-(1+gt)\xi'\}. \qquad (8)\text{ III}\end{aligned}$$

If initially there is free trade, this formula reduces to $\bar{M}_1(b+g-c-\xi')$. In contrast to the case of independence [case (1) above], *world excess demand for importables at the initial world price can be positive and the terms of trade deteriorate even if the private sector has a higher marginal propensity to consume importables than the government and the private compensated elasticity of demand for imports exceeds unity; this result can occur if government services are sufficiently strongly complementary with importables in private-sector consumption.* The same conclusion holds *a fortiori* for the case of an existing tariff.[2]

[1] This result can be obtained directly by differentiating the basic equation for this case, $M \equiv M_1+M_2 = M_1(\pi, R)+M_2(R)$, where $\delta M_1/\delta R = b/\pi$, $\delta M_2/\delta R = g$, and $R = tM_1$; it is necessary first to solve for dM_1/dt by differentiating M_1 alone. It should be noted that the stability of equilibrium requires that the denominator in this and similar expressions presented subsequently for cases (2) and (3) must be positive; this is assumed without further comment in the argument of the rest of this article.

[2] It should be noticed that if consumers treat government consumption as equivalent to personal consumption of the commodities concerned (the Baldwin case), with initial free trade $b = c-g$ and the formula is identical with that given earlier for case (2). With a tariff initially in effect the formulae are different because we have assumed that the government does not pay tariff revenue to itself on its imports.

III. The Effect of an Increase in the Tariff on the Terms of Trade: Disaggregation of the Private Sector

In the previous two sections we have analysed the effect of an increase in the tariff rate in our three cases on the assumption that the private sector could be regarded as a homogeneous unit. Abandonment of this assumption introduces three complications:

(1) In so far as consumers consume exportables and importables in differing proportions, as a result of either taste or income differences, a change in the domestic price of importables alters the distribution of real income between them.

(2) In so far as consumers own factors of production in different proportions, a change in the domestic price of importables, by altering the relative prices of factors of production, alters the distribution of earned income between them.

(3) Where the tariff proceeds are redistributed to the private sector and the marginal propensities of consumers to consume importables differ, as a result of either taste or income differences, the way in which the tariff proceeds are divided among consumers will influence the effect of redistribution on the demand for importables.

To develop the analysis of the disaggregated case we assume that the private sector consists of two typical consumers, each of whom derives his earned income from the ownership of a collection of factors used in production. We begin with case (1); once the results for this case have been developed, the modifications required for the other cases are minor. The problem in case (1) is to disaggregate the elasticity of private demand for imports.

It has been shown elsewhere by one of the present writers that the income earned by a factor owner at any particular domestic price ratio between exportables and importables can be equated with the sum of the real values of the quantities (one of which may be negative) of the two commodities which would be produced with his factors at that price ratio.[1] Accordingly, let the earned incomes of the two factor owners at the initial domestic price of importables be:

$$Y_1 = \pi P_1 + Q_1 \tag{9a}$$

and

$$Y_2 = \pi P_2 + Q_2, \tag{9b}$$

where Y represents income and P and Q quantities of importables and exportables produced, and subscripts 1 and 2 denote the two individuals. We now write the total private-sector demand for importables as the sum

[1] H. G. Johnson, 'International Trade, Income Distribution, and the Offer Curve', *Manchester School of Economic and Social Studies*, vol. xxvii, no. 3 (Sept. 1959), pp. 241–60.

of the demands of the two individuals, each of which depends on the domestic price of importables and the individual's income:[1]

$$C \equiv C_1+C_2 = C_1(\pi, Y_1)+C_2(\pi, Y_2).$$

Differentiating by π, we obtain:[2]

$$\begin{aligned}\frac{dC}{d\pi} &= \frac{\partial C_1}{\partial Y_1}\overline{P}_1+\frac{\partial C_1}{\partial \pi}+\frac{\partial C_2}{\partial Y_2}\overline{P}_2+\frac{\partial C_2}{\partial \pi}\\ &= \frac{c_1}{\pi}\overline{P}_1-\frac{\overline{C}_1}{\pi}\eta_1+\frac{c_2}{\pi}\overline{P}_2-\frac{\overline{C}_2}{\pi}\eta_2\\ &= -\frac{\overline{C}_1}{\pi}\eta_1'-\frac{\overline{C}_2}{\pi}\eta_2'-\frac{c_1}{\pi}(\overline{C}_1-\overline{P}_1)-\frac{c_2}{\pi}(\overline{C}_2-\overline{P}_2), \qquad (10\,a)\end{aligned}$$

where c_1 and c_2 are the marginal propensities to spend on importables of the two individuals, η_1 and η_2 are the price elasticities of their demands for importables from their initial incomes, and η_1' $(=\eta_1-c_1)$ and η_2' $(=\eta_2-c_2)$ are their compensated price elasticities of demand for importables.

The two terms on the right-hand side of the above expression represent the net income effects of the increased price of imports on the demands of the two individuals; the terms in parentheses are the net income-losses themselves. Unless the excess of initial consumption over the amount of importables the individual's factors would produce bears the same ratio to the initial amount of income for each individual, the price increase will alter the relative real incomes of the individuals; that individual will gain relatively who initially spent the smaller proportion of his income on importables, factors being owned in equal ratios by the two individuals, or who possesses the higher proportion of factors used relatively intensively in the importable-good industry, initial consumption proportions being equal. If tastes, incomes, or factor-ownership ratios differ considerably, it is even possible that one individual's consumption of importables will be less than the amount of importables produced by his factors, so that that individual gains real income as a result of the increase in the price of imports; this must be true in the extreme case in which each individual owns the whole supply of one factor, since in that case the individual's income will comprise a negative quantity of the good which uses intensively the factor he does not own. If conditions are such that one individual gains real income, and his marginal propensity to spend on importables is higher

[1] For the analysis of case (2), demands depend on the sum of earned income and the amount of redistributed tariff proceeds received; but the latter is assumed constant in deriving the elasticities of consumption demand and the elasticity of import demand.

[2] For each individual $\delta Y/\delta\pi = P$, since the effect on the real value of his income of changes in the relative amounts of the two goods produced by his factors induced by the change in π can be neglected for small changes.

than that of the other individual, the aggregate income effect on demand for importables may be positive rather than negative; the individual gaining real income must have the higher marginal propensity to spend on importables for this to happen, since the other individual must be consuming both the excess of this individual's production of importables over his consumption and the country's imports from the rest of the world ($\bar{C}_1-\bar{P}_1 = \bar{M}_1+\bar{P}_2-\bar{C}_2$). If the aggregate income effect on demand for imports is positive it may outweigh the negative effects of the compensated elasticities, so that the aggregate effect of an increase in the price of importables is to increase the quantity of imports demanded.

This possibility can be shown by re-writing $dC/d\pi$ in the form

$$\frac{dC}{d\pi} = -\frac{\bar{C}_1}{\pi}\eta'_1-\frac{\bar{C}_2}{\pi}\eta'_2-\left(\frac{c_2}{\pi}-\frac{c_1}{\pi}\right)(\bar{C}_2-\bar{P}_2)-\frac{c_1}{\pi}\bar{M}_1. \qquad (10\,b)$$

If individual 2 has the higher marginal propensity to consume importables and his factors produce more importables than he consumes, the second-to-last term on the right will be positive. The quantity of importables demanded will increase when the price of importables rises if

$$(c_2-c_1)(\bar{C}_2-\bar{P}_2) > \bar{C}_1\eta'_1+\bar{C}_2\eta'_2+c_1\bar{M}_1.$$

The total change in private demand for imports resulting from an increase in the domestic price of importables is the difference between the change in consumption demand and the increase in domestic production. Hence the disaggregated elasticity of private demand for imports is:

$$\begin{aligned}\xi &= \left(\frac{\bar{P}}{\bar{M}_1}\epsilon+\frac{\bar{C}_1}{\bar{M}_1}\eta'_1+\frac{\bar{C}_2}{\bar{M}_1}\eta'_2+c_1+(c_2-c_1)\frac{\bar{C}_2-\bar{P}_2}{\bar{M}_1}\right)\\ &= \{\xi'+c_1+(c_2-c_1)m_2\}, \qquad (11)\end{aligned}$$

where $m_2 = (\bar{C}_2-\bar{P}_2)/\bar{M}_1$ is the proportion of the country's imports consumed, net, by individual 2. If m_2 is negative, individual 2 is a 'net supplier' of importables to the economy. For convenience we shall assume in what follows that individual 2 has the higher marginal propensity to consume importables ($c_2 > c_1$).

The formula for the effect of an increase in the tariff rate in the *disaggregated case* (*1*) is readily obtained by substituting the expression for the disaggregated elasticity of private demand for imports just derived into the formula [equation (3)] given in Section I above. The resulting formula is:

$$\frac{dM}{dt} = \bar{M}_1\left(g-(1+gt)\frac{c_1}{\pi}-\frac{1+gt}{\pi}(c_2-c_1)m_2-\frac{1+gt}{\pi}\xi'\right). \qquad (12)\ \text{IV}$$

In the initial free-trade case this reduces to

$$\frac{dM}{dt} = \bar{M}_1\{g-c_1-(c_2-c_1)m_2-\xi'\}.$$

The chief modification to the preceding analysis of case (1) introduced by disaggregation which emerges from this formula is that *it is not necessary for the government to have a higher marginal propensity to consume importables than the private sector for the tariff increase to give rise to a positive excess demand for importables in the world market* and so necessitate a deterioration in the terms of trade. *Such a deterioration can occur even though the government has a lower marginal propensity to consume importables from an increment of tariff revenue than does either individual from an increment in his income,* if the individual with the higher marginal propensity to consume importables is a net supplier of importables to the economy (m_2 is negative in the above formula). Similarly, even in the case of initial free trade a deterioration of the terms of trade does not require an inelastic compensated private demand for imports.

To obtain the formula for the effect of the tariff increase in the *disaggregated case* (2) from the formula given [equation (4)] for the aggregated case (2) in Section I, it is necessary both to substitute the disaggregated expression for the aggregate elasticity of private demand for imports and to replace the single marginal propensity to consume importables used in analysing the effect of the change in the amount of redistributed tariff proceeds by an average of the marginal propensities of the two individuals, weighted by the proportions in which they share in the redistributed tariff proceeds. The resulting formula is:

$$\frac{dM}{dt} = \frac{\bar{M}_1}{1+(1-\bar{c})t}(\bar{c}-\xi) = \frac{\bar{M}_1}{1+(1-\bar{c})t}\{(c_2-c_1)(s_2-m_2)-\xi'\}, \quad (13)\ \text{V}$$

where s_2 is the share of individual 2 in marginal redistributed tariff proceeds, and $\bar{c}$ $[= c_1+s_2(c_2-c_1)]$ is the weighted average marginal propensity to spend redistributed tariff proceeds on importables. This formula shows that, in contrast to the aggregated case (2), *in the disaggregated case* (2) *the tariff increase does not necessarily produce a negative world excess demand for importables* and turn the terms of trade in the tariff-increasing country's favour. *The reverse is possible if the share in the redistributed tariff proceeds of the individual with the higher marginal propensity to consume importables is larger than the proportion of the initial quantity of imports he consumes.* This will be the case, for example, if tariff proceeds are redistributed in proportion to income and (for reasons discussed above) the quantity of imports he consumes is smaller in relation to his income than is the quantity consumed by the other individual in relation to the latter's income—so that this individual is overcompensated for the income effect of the increased domestic price of importables. It should be noticed also that, since the individual with the higher marginal propensity to consume importables may be a net supplier of importables to the economy (m_2

negative) there may be *no* way of allocating the marginal change in tariff proceeds between the two individuals which would compensate both of them exactly for the income effect of the tariff increase.

To obtain the formula for the effect of the tariff increase in the *disaggregated case* (*3*) from the formula [equation (8)] given for the aggregated case (3) in Section II above, it is necessary to substitute the disaggregated expression for the elasticity of private demand for importables in that formula and to rewrite the dependence effect as the sum of the dependence effects on the two individuals (which may be of different magnitudes and opposite signs). The resulting formula is:

$$dM/dt = \frac{\bar{M}_1}{1+(1-b_1-b_2)t}\{b_1+b_2+g\pi-(1+gt)c_1-(1+gt)(c_2-c_1)m_2-(1+gt)\xi'\}. \quad (14)\ \text{VI}$$

The main modification introduced by disaggregation arises from the possibility that the individual with the higher marginal propensity to consume importables will gain real income from the increase in the domestic price of importables; the nature of this modification has already been discussed in connexion with the disaggregated case (1).

IV. The Effect of an Increase in the Tariff on the Terms of Trade: Variable Supplies of Factors of Production

In the preceding sections we have successively relaxed three of the assumptions of the traditional analysis of the effect of a tariff on the terms of trade—the assumptions of initial free trade, independence of private from government consumption, and homogeneity of the private sector. We must now relax the fourth assumption, constancy of supplies of factors of production. The analysis of the effects of a tariff when factor supplies are variable is the subject of a paper by Murray C. Kemp, which we have been privileged to read and which suggested the inclusion of the present section of this article to us. We gratefully acknowledge his priority, and also our indebtedness to R. W. Jones, who has since produced a broader study of variability of factor supplies in international trade;[1] our own analysis takes a slightly different form from theirs, better adapted to the general purpose of this article.

For simplicity of analysis we shall assume that only the quantity of labour is variable. This assumption has some economic justification,

[1] M. C. Kemp, 'Tariffs, Protection, and the Distribution of National Income', and R. W. Jones, 'General Equilibrium with Variable Labor Supply'; these two papers are to be merged in a forthcoming joint article, 'Variable Labour Supply and the Theory of International Trade'.

inasmuch as we may assume that the quantity of labour available for employment from a given total stock depends on the relative attractiveness at the margin of the real consumption obtainable by offering labour and of the leisure obtained by not offering it, to the owner of labour, while the total stock of capital, having no alternative utility-yielding use, is always available for employment. The real consumption enjoyed with the employment of a given quantity of labour depends on the quantity of labour employed, the quantity of capital owned, the real wage rate and real rent rate measured in terms of exportable goods, and the relative price of importables; but the real wage and real rent rates are linked through the technology of the economy to the relative price of importables, so that the latter determines the former. In cases (2) and (3), though in different ways, real consumption also depends on the amount of tariff revenue.

With leisure as the alternative to labour the quantity of labour supplied will decrease with an increase in the amount of real income that could be enjoyed with the employment of the initial amount of labour, since some (but not all, barring inferiority of real consumption) of the potential increase in real consumption will be consumed in the form of leisure. The real consumption enjoyable from the employment of the initial amount of labour remaining constant, an increase in the real wage rate will generally, but not always, increase the quantity of labour supplied. Such a 'compensated' increase in the real wage-rate has two effects: it raises the price of labour (the cost of leisure) in terms of goods, and so induces a substitution of labour, and the real consumption it makes possible, for leisure—an increase in the quantity of labour supplied; but it also reduces the relative price of the commodity in whose production labour is used relatively unintensively. If this commodity is substitutary with leisure, the effect is again to induce an increase in the quantity of labour supplied; but if it is complementary with leisure, the effect is to induce a decrease in the quantity of labour supplied, and this effect may be strong enough to outweigh the general tendency to substitute real consumption for leisure, and so reduce the quantity of labour supplied. This possibility we shall describe as one of strong complementarity of leisure and the capital-intensive good in consumption.

With this background, we can proceed to the analysis of the effect of a tariff increase in our three aggregative cases.

The increase in the domestic price of importables resulting from the tariff increase has two effects on the quantity of labour supplied:

(*a*) The loss of real income due to the increase in the price of importables increases the quantity of labour supplied. The loss of real income due to the increased price of importables is approximately equal to the increased cost of the initial volume of private imports, and the change in the quantity

of labour supplied for this reason is therefore:

$$\frac{\partial L}{\partial Y'}\frac{\partial Y'}{\partial \pi}\frac{d\pi}{dt} = (-l)(-\bar{M}_1) = \bar{M}_1 l, \tag{15a}$$

where Y' represents real income and l represents the marginal propensity to consume leisure when potential real income increases; l must be positive and smaller than $1/w$ (w being the real wage-rate) on the assumption that neither leisure nor real consumption is inferior.

(*b*) The change in the relative price of labour due to the change in the relative price of importables alters the quantity of labour supplied, the direction and extent of the change being determined by the elasticity of the real wage rate with respect to the price of importables and the elasticity of supply of labour with respect to the real wage-rate. The change in the quantity of labour supplied is:

$$\frac{\partial L}{\partial w}\frac{\partial w}{\partial \pi}\frac{d\pi}{dt} = \frac{\bar{L}}{\pi}\lambda e_w, \tag{15b}$$

where $\lambda \{= (w/L)\partial L/\partial w\}$ is the compensated elasticity of supply of labour, and is positive unless there is strong complementarity between the capital-intensive commodity and leisure, and $e_w \{= (\pi/w)\partial w/\partial \pi\}$ is the elasticity of the real wage-rate with respect to the price of importables. Since a rise in the price of importables will raise or lower the real wage-rate according as labour is used relatively intensively in the importable-goods or the exportable-goods industry, e_w will be positive or negative according as the importable-goods industry is labour-intensive or capital-intensive.

The change in the quantity of labour initially supplied due to these two effects of the increased domestic price of importables resulting from the tariff increase is therefore:

$$\frac{\partial L}{\partial t} = \frac{\partial L}{\partial \pi}\frac{d\pi}{dt} = \frac{\bar{L}}{\pi}\lambda e_w + \bar{M}_1 l. \tag{16}$$

This change in the quantity of labour supplied due to the increase in the domestic price of importables has two effects on the quantity of imports demanded (in addition to those analysed in Section I):

(1) The change in the quantity of labour supplied changes the amount of income earned by the private sector and so changes the quantity of importables demanded. The change in earned income is approximately equal to the wage rate multiplied by the change in the quantity of labour supplied, and the change in the quantity of imports demanded due to a change in earned income is determined by the marginal propensity to consume importables. Hence the change in the quantity of importables

demanded due to the effect of the tariff increase on the domestic price of importables is:

$$\frac{\partial C}{\partial \bar{L}}\frac{\partial L}{\partial t} = \frac{cw}{\pi}\left(\frac{\bar{L}}{\pi}\lambda e_w + \bar{M}_1 l\right). \tag{17a}$$

(2) The change in the quantity of labour supplied changes the amount of importables domestically produced. This change can be deduced from one of the established propositions of the theory of international trade and economic growth, according to which an increase in the quantity of one factor at a given domestic price ratio must be absorbed by transferring both factors out of the industry which uses that factor unintensively into the other industry, where they are combined with the new quantities of the increased factor in the more intensive ratio optimal in that industry; and conversely for a decrease in the quantity of a factor.[1] The changes in the outputs of the two industries, per unit change in the total amount of a factor supplied, are determined by the factor ratios in the two industries and the average output per unit of the factor whose supply is altered in the relevant industry.[2]

It follows from this principle that the change in the output of importables due to a change in the quantity of labour supplied must be greater absolutely than the change in national income due to the same cause, so that the effect on importable goods production dominates the net effect on imports demanded of a change in the quantity of labour supplied. Also, the change in the domestic output of importable goods due to an increase in the quantity of labour supplied must be of the same sign as the change in the real wage-rate due to an increase in the domestic price of importable goods. If labour is used intensively in importable-goods production, an increase in the domestic price of importables must increase the real wage-rate, and an increase in the quantity of labour must be absorbed by an expansion of production of importables at the expense of exportables; conversely, if labour is used intensively in the production of exportables, an increase in the domestic price of importables must lower the real wage-rate and an increase in the quantity of labour supplied must increase the domestic

[1] This proposition is originally due to T. M. Rybczynski, 'Factor Endowment and Relative Commodity Prices', *Economica*, N.S., vol. xxii, no. 88 (Nov. 1955), pp. 336–41. For a recent statement, see J. Bhagwati and H. G. Johnson, 'Notes on Some Controversies in the Theory of International Trade', *Economic Journal*, vol. lxx, no. 277 (Mar. 1960), pp. 74–93, especially p. 82.

[2] Let k_1 and $k_2 (< k_1)$ be the capital:labour ratios in the capital-intensive and labour-intensive industries, and a_1 and a_2 be the average products of labour in those industries. The movement of a unit of labour from the former to the latter industry releases $(k_1 - k_2)$ units of capital, which will permit the employment of an additional $(k_1 - k_2)/k_2$ units of labour in the labour-intensive industry: hence employment of an additional unit of labour in the latter industry requires a transfer of $k_2/(k_1 - k_2)$ labour units (together with the capital employed with them in the capital-intensive industry). Output in the capital-intensive industry, therefore, must fall by $k_2 a_1/(k_1 - k_2)$, and output in the labour-intensive industry rise by $a_2\{1 + k_2/(k_1 - k_2)\} = k_1 a_2/(k_1 - k_2)$ when the labour supply increases by one unit.

production of exportables at the expense of importables. Accordingly, the change in the domestic production of importable goods due to the tariff increase is:

$$\frac{\partial P}{\partial L}\frac{\partial L}{\partial t} = \rho\left(\frac{\bar{L}}{\pi}\lambda e_w + \bar{M}_1 l\right), \tag{17 b}$$

where ρ, the change in the quantity of importables domestically produced due to an increase in the quantity of labour supplied, must have the same sign as e_w and exceed w in absolute magnitude.[1]

The net change in the quantity of importables demanded by the private sector due to the change in the quantity of labour supplied resulting from the effect of the tariff increase on the real wage-rate is therefore [the difference between (17 a) and (17 b)]:

$$\frac{\partial M_1}{\partial L}\frac{\partial L}{\partial t} = \left(\frac{cw}{\pi} - \rho\right)\left(\frac{\bar{L}}{\pi}\lambda e_w + \bar{M}_1 l\right). \tag{18}$$

To allow for variability of the quantity of labour supplied in response to the increase in the domestic price of importables resulting from the tariff increase in deriving the formulae for the effect of the tariff increase on the world excess demand for importables, it is necessary to include the expression just derived in reckoning the effect of the tariff increase on the quantity of importables privately demanded. This entails adding the expression

$$-\frac{\pi}{\bar{M}_1}\frac{\partial M_1}{\partial L}\frac{\partial L}{\partial t} = (\rho\pi - cw)\left(\frac{\bar{L}}{\pi\bar{M}_1}\lambda e_w + l\right), \tag{19}$$

to the elasticity of private demand for imports in the formulae derived in Sections I and II. In this expression $(\rho\pi - cw)$ must have the same sign as ρ, because ρ exceeds w in absolute magnitude and c, the marginal propensity to consume importables, is assumed to be less than unity and therefore less than π.

In *case (1)*, where the government spends the tariff revenue and the preferences of the private sector are independent of the amount of government expenditure, this is the only adjustment required. In *case (2)*, however, the change in the amount of tariff revenue redistributed due to the tariff increase will alter the real income obtainable with the employment of the initial quantity of labour supplied and so alter the quantity of labour supplied. The change in the amount of importables demanded resulting for this reason from the increase in the tariff rate will be:

$$\frac{\partial M_1}{\partial L}\frac{\partial L}{\partial Y'}\frac{dR}{dt} = \left(\rho - \frac{cw}{\pi}\right)l\frac{dR}{dt}. \tag{20}$$

In *case (3)* the quantity of labour supplied will depend on the amount of

[1] It follows from n. 2, p. 242, that $\rho = k_x a_m/(k_x - k_m)$, where the subscripts x and m refer to the exportable-goods and importable-goods industries respectively.

government services if leisure is substitutary or complementary with government services; in this case the change in tariff revenue due to the tariff increase will change the quantity of imports demanded through its effects on the quantity of labour supplied by the amount

$$\frac{\partial M_1}{\partial L}\frac{\partial L}{\partial R}\frac{dR}{dt} = \left(\frac{cw}{\pi}-\rho\right)\alpha\frac{dR}{dt}, \tag{21}$$

where α is the change in the quantity of labour supplied due to a unit increase in government expenditure, and may be positive or negative.

In the *aggregated case* (*1*) with variable labour supply, the effect of the tariff increase on the world excess demand for importables is[1] [derived from (3) and (19)]:

$$\frac{dM}{dt} = \bar{M}_1\left\{g-(1+gt)\frac{c}{\pi}-\frac{(1+gt)}{\pi}\xi'-\frac{(1+gt)}{\pi}(\rho\pi-cw)\left(\frac{\bar{L}}{\pi\bar{M}_1}\lambda e_w+l\right)\right\}. \tag{22) VII}$$

If the elasticity of supply of labour λ is positive, and ρ is also positive, implying that importable-goods production is labour-intensive, the last term within the brackets must be positive, so that all the terms except g have a negative sign, and the traditional conclusion that an adverse movement of the terms of trade requires a governmental marginal propensity to consume importables greater than the private marginal propensity to consume them continues to hold. But if the elasticity of supply of labour λ is positive and ρ is negative, implying that exportable-goods production is labour-intensive, it is possible for the last term to be negative (in spite of the fact that the first half of it must be positive owing to the identity of signs of ρ and e_w), so that the traditional condition is not necessary in this case. If the elasticity of supply of labour λ is negative and ρ is also negative —implying that importables are capital-intensive in production and strongly complementary with leisure in consumption—the last term must be negative, so that the influence of variability of the labour supply is to increase the world excess demand for importables, and the traditional condition is not necessary for the terms of trade to turn against the country. Similarly, if the elasticity of supply of labour λ is negative and ρ is positive—exportables are capital-intensive in production and strongly complementary with leisure in consumption—the last term may be negative on balance, and again the traditional condition is not necessary for the terms of trade to turn against the country.

In the *aggregated case* (*2*), with variable labour supply, the effect of the

[1] This result is obtained, as explained above, by adding the expression for the effect of the tariff increase, via the labour supply, on the demand for importables to the elasticity of private demand for imports in the formula previously derived for the aggregated case with constant labour supply.

tariff increase on world excess demand for importables is [the sum of (4), (18), and (20)]:

$$\frac{dM_1}{dt} = \frac{\partial M_1}{\partial t} + \left(\frac{cw}{\pi} - \rho\right)\frac{\partial L}{\partial t} + \left(\frac{c}{\pi}\right)\frac{dR}{dt} + \left(\rho - \frac{cw}{\pi}\right)l\frac{dR}{dt}$$

$$= -\frac{\bar{M}_1}{\pi}\left\{\xi + (\rho\pi - cw)\left(\frac{\bar{L}}{\pi\bar{M}_1}\lambda e_w + l\right)\right\} + \left\{\frac{c}{\pi} + \left(\rho - \frac{cw}{\pi}\right)l\right\}\left(\bar{M}_1 + t\frac{dM_1}{dt}\right)$$

$$= \frac{\bar{M}_1}{1+\{1-c-(\rho\pi-cw)l\}t}\left(-\xi' - (\rho\pi - cw)\frac{\bar{L}}{\pi\bar{M}_1}\lambda e_w\right). \qquad (23)\ \text{VIII}$$

Since $(\rho\pi - cw)(\bar{L}/\pi\bar{M}_1)e_w$ must be positive, the tariff increase cannot turn the terms of trade against the country if the supply of labour is positively elastic with respect to the real wage rate (λ is positive). If the supply of labour is negatively elastic (strong complementarity of the capital-intensive commodity, whichever it is, with leisure in consumption) the terms of trade may turn against the country. Thus variability of the labour supply can reverse the traditional conclusion in the exceptional case of a negative elasticity of supply of labour.

In the *aggregated case* (*3*), with variable labour supply, the change in the amount of imports privately demanded due to the tariff increase is:

$$\frac{dM_1}{dt} = \frac{\partial M_1}{\partial t} + \left(\frac{cw}{\pi} - \rho\right)\left(\frac{\partial L}{\partial t}\right) + \left\{\frac{b}{\pi} + \left(\frac{cw}{\pi} - \rho\right)\alpha\right\}\frac{dR}{dt}$$

$$= \frac{b - \xi - (\xi\pi - cw)\{\alpha + (\bar{L}/\pi\bar{M}_1)\lambda e_w + l\}}{1+\{1-b+(\rho\pi-cw)\alpha\}t}\bar{M}_1; \qquad (24\,\text{a})$$

the change in the amount of imports demanded by the government is:

$$\frac{dM_2}{dt} = g\left(\bar{M}_1 + t\frac{dM_1}{dt}\right) = \frac{\pi - t\xi - t(\rho\pi - cw)\{(\bar{L}/\pi\bar{M}_1)\lambda e_w + l\}}{1+\{1-b+(\rho\pi-cw)\alpha\}t}g\bar{M}_1; \qquad (24\,\text{b})$$

and the change in the total quantity of imports demanded, and the world excess demand for importables, is consequently [the sum of (24 a) and (24 b)]:

$$\frac{dM}{dt} = \frac{\begin{array}{l}\pi g + b - (1+gt)\xi' - (1+gt)c - \\ -(1+gt)(\rho\pi - cw)\{(\bar{L}/\pi\bar{M}_1)\lambda e_w + l\} - (\rho\pi - cw)\alpha\end{array}}{1+\{1-b+(\rho\pi-cw)\alpha\}t}\bar{M}_1. \qquad (25)\ \text{IX}$$

In the case of initial free trade, which we shall consider for simplicity, this reduces to:

$$\frac{dM}{dt} = \left[g + b - \xi' - c - (\rho\pi - cw)\left(\frac{\bar{L}}{\bar{M}_1}\lambda e_w + l + \alpha\right)\right]\bar{M}_1.$$

It follows from this formula that, even with initial free trade, an inverse relation between government expenditure and private demand for importables, and a government marginal propensity to consume importables less than that of the private sector, an increase in the tariff rate can turn the

terms of trade against the country. This requires the final term of the foregoing expression to be negative, which in turn requires $\left(\lambda+\frac{l+\alpha}{e_w}\frac{\bar{M}_1}{\bar{L}}\right)$ to be negative. This is possible in the following cases:

(i) Negative elasticity of supply of labour ($\lambda < 0$), requiring strong complementarity of the capital-intensive good (which may be either commodity) with leisure in consumption; the necessary condition for the term to be negative in this case is $-\lambda > \frac{l+\alpha}{\bar{L}e_w}\bar{M}_1$.

(ii) Positive elasticity of supply of labour ($\lambda > 0$) and negative elasticity of the wage-rate with respect to the price of importables ($e_w < 0$), which requires the exportable-goods industry to be relatively labour-intensive, together with $(l+\alpha)$ positive, which, since l is necessarily positive, is consistent with the quantity of labour supplied either increasing or decreasing as government expenditure increases; the necessary condition for the term to be negative in this case is $\frac{l+\alpha}{\lambda}\frac{\bar{M}_1}{\bar{L}} > -e_w$.

(iii) Positive elasticity of supply of labour ($\lambda > 0$) and positive elasticity of the wage-rate with respect to the price of importables ($e_w > 0$), which requires the importable-goods industry to be labour-intensive, together with $(l+\alpha)$ negative, which, since l is necessarily positive, requires that an increase in government expenditure reduce the quantity of labour supplied; the necessary condition for the term to be negative in this case is $-\alpha > \frac{\bar{L}\lambda e_w}{\bar{M}_1}+l$.

To obtain the formulae for the effect of the tariff increase on world excess demand for importables in the *disaggregated cases* it is necessary to introduce appropriately weighted averages of the expressions for the income and substitution effects of the increase in the domestic price of importables due to the tariff increase on the quantity of labour supplied, and of the effects on labour supplied of the change in the tariff revenue due to the tariff increase, for the two individuals. The resulting formulae will not be reproduced here; the general nature of the effects of allowing for differences between members of the private sector can be inferred from the argument of this and the preceding section.

V. The Effect of an Increase in the Tariff on the Domestic Price Ratio

The previous sections of this article have been concerned with generalizing the theory of the effect of a tariff increase on the terms of trade of the tariff-raising country. In this final section we consider the conditions under

which a tariff increase may improve the terms of trade so much that the internal price of importable goods actually falls, a question which is of particular interest in connexion with the effect of the tariff in redistributing income between the owners of factors of production. The traditional analysis concludes (as mentioned in the introduction) that such an improvement requires that the marginal propensity to spend on domestic goods of the government or the private sector, whichever spends the tariff proceeds, must exceed the foreign elasticity of demand for the country's exports (so that, barring inferiority of importables in private or government consumption, that elasticity must be less than unity).

Like the terms of trade problem, this problem can be simplified by considering the effect of the tariff increase on world excess demand for importables at a given price for them; in this case we consider the effect on excess demand at the initial domestic price of importables. World excess demand for importables is symbolized below by $M' \equiv M - M_s$, where M is the quantity of imports demanded by the tariff-imposing country and M_s the quantity of imports supplied by the rest of the world; initially $M' = 0$. The tariff increase will raise or lower the internal price of importables according as it gives rise to an excess demand for or excess supply of importables in the world market at the initial domestic price of importables. We begin with our three aggregated cases, assuming that the private sector can be treated as homogeneous and that factor supplies are constant. The effect of the tariff increase on the world excess demand for importables is then the net resultant of three effects of the tariff increase:

(1) The tariff increase reduces the price offered to foreign suppliers for imports, and so alters the quantity supplied at the initial domestic price ratio. The change in the quantity supplied is

$$\frac{dM_s}{dt} = \frac{dM_s}{dp}\frac{dp}{dt} = \frac{dM_s}{dp}\frac{d}{dt}\left(\frac{\pi}{1+t}\right) = -\frac{\epsilon_f}{\pi}\overline{M}_s = \frac{1-\eta_f}{\pi}\overline{M}, \tag{26}$$

where ϵ_f is the foreign elasticity of supply of imports and η_f is the elasticity of foreign demand for the country's exports. For the quantity of imports supplied to increase when the price offered for them falls, it is necessary for the foreign import demand elasticity to be less than unity. We shall not investigate the determinants of the foreign import demand elasticity; but the analysis of the preceding sections shows that, in addition to the usual possibility of a low demand elasticity due to a low elasticity of substitution between exportables and importables in foreign consumption, the foreign elasticity of demand for imports may be less than unity, and even negative, if the factor used intensively in foreign production of exportables has the higher marginal propensity to consume exportables, or if the supply curve of that factor is backward-rising.

(2) Where the government spends the tariff proceeds, and allocates expenditure between exportables and importables on the basis of world market prices, the reduction in the world market price increases the quantity of imports it demands from a given tariff revenue. The change in the quantity of imports demanded on this account is

$$\frac{\delta M_2}{\delta p}\frac{dp}{dt} = -\eta_g \bar{M}_2 \frac{d}{dt}\left(\frac{\pi}{1+t}\right) = \frac{\eta_g}{\pi}\bar{M}_2, \tag{27}$$

where η_g is the elasticity of government demand for imports.

(3) The increase in the tariff rate increases the tariff proceeds derived from the initial volume of imports and so increases the quantity of imports demanded to an extent which is differently determined in the different cases. The increase in the tariff revenue derived from the initial volume of imports is

$$\frac{\partial R}{\partial t} = \frac{\partial}{\partial t}\left(\frac{t}{1+t}\pi\bar{M}_1\right) = \frac{\bar{M}_1}{\pi}.$$

(*a*) Where the government spends the tariff revenue and private-sector demand is independent of the level of government activity (case (1)), the increase in the quantity of imports demanded due to the increase in the tariff revenue is:

$$\frac{\partial M_2}{\partial R}\frac{\delta R}{\delta t} = g\frac{\partial R}{\partial t} = \frac{g}{\pi}\bar{M}_1.$$

(*b*) Where the tariff revenue is redistributed to the private sector (case (2)), the increase in the quantity of imports demanded is

$$\frac{dM_1}{dt} = \frac{\partial M_1}{\partial R}\frac{dR}{dt} = \frac{c}{\pi}\left(\frac{\partial R}{\partial t} + t\frac{dM_1}{dt}\right) = \frac{c}{1+(1-c)t}\frac{\bar{M}_1}{\pi}.$$

(*c*) In case (3), where the government spends the tariff revenue and private demand for importables is dependent on the amount of governmental services provided, the tariff increase has a fourth effect, which is most conveniently considered in conjunction with the third. For, in addition to increasing the level of government consumption through increasing the amount of tariff revenue, the increase in the tariff rate, by reducing the price offered to foreign suppliers, both increases the real level and alters the composition of government consumption from the initial amount of tariff revenue. These changes, as well as the increase in tariff revenue, will have a dependence effect on the private demand for importables, which effect will differ according to the precise nature of the dependence of private demand on governmental activity. The latter must accordingly be specified, whereas it could legitimately be ignored in analysing the effect of the tariff increase on the terms of trade. Three cases can be distinguished: (3*a*) dependence on total real governmental consumption, (3*b*) dependence

on the quantity of importables consumed by the government, and (3*c*) dependence on the quantity of exportables consumed by the government.

A *general formula for case* (3) which can be adapted to fit these alternative assumptions about the nature of dependence can be derived as follows: define B as the increase in quantity of importables privately demanded when government revenue (expenditure) increases by one unit, and A as the increase in government revenue that would produce the same effect on private demand for importables as the change in whatever aspect of government expenditure influences that demand that results from the tariff increase, tariff revenue being held constant. Then the increase in the quantity of importables privately demanded due to the effect of the tariff increase on governmental consumption is

$$\frac{dM_1}{dt} = \frac{\partial M_1}{\partial R}\left(\frac{dR}{dt}+A\right) = B\left(\frac{\delta R}{\delta t}+t\frac{dM_1}{dt}+A\right) = \frac{B(\bar{M}_1/\pi+A)}{1-Bt};$$

the increase in the quantity of imports demanded by the government due to the increase in tariff revenue is

$$\frac{dM_2}{dt} = \frac{\delta M_2}{\delta R}\frac{dR}{dt} = g\left(\frac{\delta R}{\delta t}+t\frac{dM_1}{dt}\right) = \frac{g(\bar{M}_1/\pi+ABt)}{1-Bt};$$

and the total change[1] in the quantity of importables demanded resulting from the effect of the increase in the tariff rate on governmental expenditure and the associated dependence effect on private demand for importables is

$$\frac{dM}{dt} = \frac{(g+B)(\bar{M}_1/\pi)+AB(1+gt)}{1-Bt} = \frac{g\bar{M}_1}{\pi}+\frac{(1+gt)B(\bar{M}_1/\pi+A)}{1-Bt}. \quad (28)$$

The reduction in the price of imports due to the increase in the tariff (tariff proceeds remaining constant) increases governmental real income by $-\bar{M}_2\,dp/dt = \bar{M}_2/\pi$, increases governmental consumption of importables by $(\delta M_2/\delta p)(dp/dt) = \eta_g(\bar{M}_2/\pi)$, and alters governmental consumption of exportables by $-\delta(p\bar{M}_2)/\delta t = (1-\eta_g)(\bar{M}_2/\pi)$. Hence the parameter A in the general formula is equal to $\bar{M}_2/\pi$ in case (3*a*), $(\eta_g/g)(\bar{M}_2/\pi)$ in case (3*b*), and $\{(1-\eta_g)/(1-g)\}(\bar{M}_2/\pi)$ in case (3*c*). The parameter B in the formula is equal to b_r/π in case (3*a*), $b_m g/\pi$ in case (3*b*), and $b_x(1-g)/\pi$ in case (3*c*), where the b's are coefficients relating the increase in private expenditure on importables to the increase in real government consumption, government consumption of importables, and government consumption of exportables, which induce it in the three cases. The total changes in the quantity of imports demanded resulting from the effects of the tariff increase under analysis in the three sub-cases are obtained by inserting these values in

[1] This change excludes the direct effect of the lower price of imports in increasing government consumption of them from the initial tariff revenue, discussed under (2) above.

the general formula; since the results are rather cumbrous, and are contained in the formulae for the effect of the tariff increase on the excess demand for importables presented below, they are not reproduced here.

In *case* (*1*) the total effect of the tariff increase on world excess demand for importables at the initial domestic price of importables is

$$\frac{dM'}{dt} = \frac{dM}{dt} - \frac{dM_g}{dt} = \left(g + \eta_g' \frac{\overline{M}_2}{\overline{M}} - 1 + \eta_f\right)\frac{\overline{M}}{\pi}, \qquad (29)\ \text{X}$$

where η_g' is the compensated elasticity of government demand for imports. For this to be negative, representing an excess supply of importables and necessitating a reduction in the world and domestic price of importables to restore equilibrium, requires[1]

$$(1-g) - \frac{\overline{M}_2}{\overline{M}}\eta_g' > \eta_f.$$

Whether free trade ($\overline{M}_2 = 0$) or a tariff ($\overline{M}_2 > 0$) is initially in force, the internal price of imports can fall only if the government's marginal propensity to spend on exportables $(1-g)$ exceeds the foreign elasticity of demand for imports (η_f), which in turn requires an inelastic foreign demand for imports unless importables are inferior in government consumption at the pre-existing level of tariff proceeds. Where a tariff is initially in force, an excess of $(1-g)$ over η_f is a necessary but not a sufficient condition for the internal price of importables to fall.

In *case* (*2*) the total effect of the tariff increase on the world excess demand for importables is[2]

$$\frac{dM'}{dt} = \left(\frac{c}{1+(1-c)t} - 1 + \eta_f\right)\frac{\overline{M}_1}{\pi}. \qquad (30)\ \text{XI}$$

A decrease in the world and domestic price of importables in this case requires

$$(1-c) > \frac{\eta_f}{\pi - \eta_f t}.$$

This requires the private sector's marginal propensity to spend on export-

[1] This result differs from that derived by Metzler in the supplementary paper referred to in n. 1, p. 226 (op. cit., especially equation (7), p. 439). The reason is that Metzler, in dealing with the case, writes governmental demand as a function of the tariff proceeds measured in importable goods. whereas we write it as a function of tariff proceeds measured in exportable goods. On his assumption, $\delta R/\delta t = \delta(tM_1)/\delta t = \overline{M}_1$, as contrasted with our $\delta R/\delta t = \overline{M}_1/1+t$. In dealing with our case (2), Metzler writes private demand as a function of tariff proceeds measured in exportable goods, and obtains a result identical with ours. Metzler's technique for the former case is inferior to ours, since it means that all the income effect of an import price change on government demand falls on the exportable good.

[2] Our earlier analysis of this case, presented in J. Bhagwati, 'Protection, Real Wages and Real Incomes', *Economic Journal*, vol. lxix, no. 276 (Dec. 1959), pp. 733–48, p. 746, and explained in note 3 to that page, is erroneous; in the derivation of the excess demand for importables, the changes in quantities of importables demanded and supplied are confused. The formula presented in that paper should be replaced by that presented here.

ables ($1-c$) to exceed the foreign elasticity of demand for imports when free trade initially prevails, but not when there is a pre-existing tariff; it is always necessary, however, for the foreign demand for imports to be inelastic (barring inferiority of importables).

In *case* (*3*) the total effect of the tariff increase on world excess demand for importables is

$$\frac{dM'}{dt} = \left(\frac{b_r(1+gt)}{1+(1-b_r)t} + g + \eta_g' \frac{\bar{M}_2}{\bar{M}} - 1 + \eta_f\right)\frac{\bar{M}}{\pi} \qquad \text{(31 a) XII}$$

when private demand is influenced by real government consumption;

$$\frac{dM'}{dt} = \left\{\frac{\pi+b_m}{1+(1-b_m g)t}\left(g\frac{\bar{M}_1}{\bar{M}} + \eta_g \frac{\bar{M}_2}{\bar{M}}\right) - 1 + \eta_f\right\}\frac{\bar{M}}{\pi} \qquad \text{(31 b) XIII}$$

when private demand is influenced by governmental consumption of importables; and

$$\frac{dM'}{dt} = \left(\frac{b_x(1-g)+g\pi}{1+(1-b_x+b_x g)t}\frac{\bar{M}_1}{\bar{M}} + \frac{b_x(1+gt)+\pi(1-b_x)\eta_g}{1+(1-b_x+b_x g)t}\frac{\bar{M}_2}{\bar{M}} - 1 + \eta_f\right)\frac{\bar{M}}{\pi} \qquad \text{(31 c) XIV}$$

when private demand is influenced by governmental consumption of exportables.

For simplicity we consider only the case in which private demand is influenced by the level of government consumption [case (3*a*), equation (31 a)]. In this case the tariff increase will lower the domestic price of importables if

$$(1-g) - \frac{b_r(1+gt)}{1+(1-b_r)t} - \eta_g' \frac{\bar{M}_2}{\bar{M}} > \eta_f. \qquad (32)$$

If an increase in government expenditure has the indirect effect of increasing private demand for importables ($b_r > 0$) the tariff can reduce the domestic price of importables only if the government's marginal propensity to spend on exportables is greater than the foreign elasticity of demand for imports, which (barring inferior goods) must be less than unity.[1] But if an increase in government expenditure has the indirect effect of reducing private demand for importables ($b_r < 0$), the tariff can reduce the domestic price of importables even though the government's marginal propensity to spend on exportables is less than the foreign elasticity of demand for imports and even though the latter is greater than unity.

Since the analysis of the effect of a tariff increase on the equilibrium domestic price of importables obtains its results from the effect of the tariff increase on world excess demand at the initial domestic price of importables, *relaxation of the assumption that the private sector can be treated*

[1] An exception is possible if $b_r > 1+t/t$.

as an aggregate makes no essential difference to the results: since domestic earned income and its distribution are unchanged if the domestic price of importables is unchanged, disaggregation requires merely the replacement of the aggregate marginal propensity to consume importables by an average of the marginal propensities of the two individuals, weighted by their shares in redistributed tariff proceeds, in case (2), and the replacement of the aggregate dependence coefficient by the sum of the coefficients for the two individuals, in case (3). For the same reason, *variability of the quantity of labour supplied* in response to changes in factor prices will make no difference to the various formulae, since the real wage-rate and real rent remain constant by the assumption of a constant internal price of importables. But variability in response to changes in the amount of tariff revenue redistributed will make a difference in case (2) and variability in response to changes in the amount and composition of real government consumption will make a difference in case (3).

In both cases, allowance for variability of the quantity of labour supplied involves introducing another effect of the tariff increase on the world excess demand for importables, the effect of the change in tariff revenue or real government consumption on the quantity of labour supplied and so on the quantity of importables domestically produced and the income available for private expenditure. These effects have already been discussed in connexion with the analysis of the effect of the tariff increase on the terms of trade.

Allowing for variability of the labour supply in response to changes in the amount of tariff revenue redistributed, the total effect of the tariff increase on world excess demand for importables in case (2) is

$$\frac{dM'}{dt} = \left(\frac{c+(\pi\rho-cw)l}{1+\{1-c-(\pi\rho-cw)l\}t} - 1+\eta_f\right)\frac{\overline{M}_1}{\pi}. \qquad (33)\ \text{XV}$$

The corresponding condition for the tariff increase to lower the domestic price of importables is

$$(1-c)-(\pi\rho-cw)l > \frac{\eta_f}{\pi-\eta_f t}.$$

It follows from this inequality that, even in the case of initial free trade [where the inequality reduces to $(1-c)-(\rho-cw)l > \eta_f$] it is not necessary for the private marginal propensity to spend on exportables to exceed the foreign elasticity of demand for imports for the tariff to lower the domestic price of importables; since $\pi\rho$ is necessarily greater in absolute value than cw, a reduction of the domestic price of importables with $\eta_f > 1-c$ requires a negative ρ, which in turn means that labour is used intensively in the exportable-goods industry. If labour is used intensively in the exportable-

goods industry, the domestic price of importables can fall even if the foreign demand for imports is elastic.

Allowing for variability of the labour supply in response to changes in the amount of real government consumption—the only variant of *case* (*3*) we shall consider[1]—the total effect of the tariff increase on world excess demand for importables is

$$\frac{dM'}{dt} = \left(\frac{\{b_r-(\pi\rho-cw)\alpha_r\}(1+gt)}{1+\{1-b_r+(\pi\rho-cw)\alpha_r\}t}+g+\eta_0'\frac{\overline{M}_2}{\overline{M}}-1+\eta_f\right)\frac{\overline{M}}{\pi}, \tag{34) XVI}$$

where α_r is the change in the quantity of labour supplied due to a unit increase in real government consumption. The corresponding condition for the tariff increase to lower the domestic price of importables is

$$(1-g)-\frac{b_r-(\pi\rho-cw)\alpha_r}{1+\{1-b_r+(\pi\rho-cw)\alpha_r\}t}(1+gt)-\eta_0'\frac{\overline{M}_2}{\overline{M}} > \eta_f.$$

In the initial free-trade case, this reduces to

$$(1-g)-b_r+(\rho-cw)\alpha_r > \eta_f;$$

and it follows from this formula that even if the dependence effect of a change in government revenue is positive, the internal price of importables may fall even though the government's marginal propensity to spend on exportables is less than the foreign elasticity of demand for imports and the latter is greater than unity. This can occur if *either* ρ is positive, implying that labour is used relatively intensively in the importable-goods industry, *and* α_r is positive, implying that the quantity of labour supplied increases when real government consumption increases, *or* ρ is negative, implying that labour is used relatively intensively in the exportable-goods industry, *and* α_r is negative, implying that the quantity of labour supplied decreases as real government consumption increases. Similar modifications apply to the general case in which a tariff is in force in the initial situation.

To allow for variability of the quantity of labour supplied in the disaggregated cases (2) and (3) it is necessary merely to replace c, b, $(\rho\pi-cw)l$ and $(\rho\pi-cw)\alpha_r$ by appropriately weighted sums of the corresponding expressions for the two separate individuals. The nature of the resulting modifications in the analysis of the effects of an increase in the tariff rate on the domestic price of importables is evident from the preceding analysis, and will not be developed further here.

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[1] Since allowing for variability of labour supply requires merely the addition of $(cw-\rho\pi)$, multiplied by the α relating labour supply to whatever aspect of governmental consumption it depends on, to the corresponding b term in the parameter B in the general formula developed above, the interested reader can easily work out the results for the other two variants for himself.

NOTES ON THE ELASTICITY OF DERIVED DEMAND

By M. BRONFENBRENNER

Introduction

A STANDARD problem in the theory of income distribution has long been the determination of the elasticity of the derived market demand for productive services (factors of production) and for intermediate products. Under the possible impression that this problem was solved, attention has, however, shifted in the past generation to the allied problem of modifying the so-called 'fundamental equation of value theory'—the Slutsky equation of 1915—to show how the quantities of services demanded by individual competitive firms vary with their prices and with the characteristics of the production function.[1] These notes will return to the historically prior and more obviously policy-relevant problem of the market elasticities of derived demand.

The Conventional Solution

Not the least of the contributions to economics of Alfred Marshall's *Principles*, both in its literary text and in its mathematical notes, was what became the conventional solution of our problem, the determination

[1] The date of the shift in emphasis may be set fairly accurately at 1938, with the simultaneous and largely independent contributions of R. G. D. Allen in England, Jacob L. Mosak in the United States, and Heinrich von Stackelberg in Germany.

If q is the product of a profit-maximizing firm without budgetary restrictions, if $x_1, x_2, \ldots, x_m$ are the services entering into its production according to the production function:

$$q = F(x_1, x_2, \ldots, x_m),$$

and if D is the bordered Hessian determinant of the first and second derivatives of F:

$$D = \begin{vmatrix} F_{11} & F_{12} & \cdot & \cdot & F_{1m} & F_1 \\ F_{21} & F_{22} & \cdot & \cdot & F_{2m} & F_2 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ F_{m1} & F_{m2} & \cdot & \cdot & F_{mm} & F_m \\ F_1 & F_2 & \cdot & \cdot & F_m & 0 \end{vmatrix}.$$

These and later writers have shown that the demand for x_i varies with its price p_i according to the equation:

$$\frac{\partial x_i}{\partial p_i} = -\frac{D_{ii}}{D}.$$

In elasticity terms, denoting by λ_i the elasticity of demand for x_i, and equating each factor price p_i with its marginal product F_i:

$$\lambda_i = -\frac{D_{ii}}{D}\frac{F_i}{x_i}.$$

For a textbook presentation and derivation, consult James M. Henderson and Richard E. Quandt, *Microeconomic Theory* (New York: McGraw-Hill, 1958), pp. 74 f.

of the market elasticity of derived demand. Worked out in the text for a productive service (plasterers' labour) and in the appendix for an intermediate good (knife-handles), Marshall's development resulted in four 'laws' of the elasticity of derived demand. These laws were perhaps stated more clearly by Marshall's disciple and successor A. C. Pigou than by Marshall himself.[1] We shall quote Pigou's statement, rearranging it so as to present the four laws, rules, or propositions in Marshall's original order:

Marshall's first law: 'The demand for anything is likely to be more elastic, the more readily substitutes for that thing can be obtained.'

Marshall's second law: 'The demand for anything is likely to be more elastic, the more elastic is the demand for any further thing which it contributes to produce.'

Marshall's third law: 'The demand for anything is likely to be less elastic, the less important is the part played by the cost of that thing in the total cost of some other thing, in the production of which it is employed.'

Marshall's fourth law: 'The demand for anything is likely to be more elastic, the more elastic is the supply of the co-operant agents of production.'

As occasionally happens in Marshall, the literary statement transcends the mathematical proof. The latter is given in note xv of the Mathematical Appendix. The elasticity of derived demand of this note may be rendered in modern dress:

$$\lambda = \left(\frac{1}{k\eta} + \frac{1-k}{ek}\right)^{-1} = \frac{ke\eta}{e+\eta(1-k)}, \tag{1}$$

where η is the elasticity of demand for the product (defined positive in normal cases), k the (necessarily positive) share of the relevant factor in total cost, and e the elasticity of supply of other factors taken together (which may be negative).

Expression (1) is fundamental to the doctrinal history of the elasticity of derived demand, but not to the derivation of Marshall's four laws. It does not, for example, permit the testing of the first law, since it includes no measure of substitutability. It was in fact drawn up to illustrate a case—knife-handles in knife manufacture—where what we now call the elasticity of substitution was assumed to be zero. The other laws may be tested by taking partial derivatives of (1) with respect to η, k, and e in turn. (All three derivatives should be positive for Marshall's last three

[1] A. C. Pigou, *Economics of Welfare* (4th edition; London: Macmillan, 1948), pp. 682–5; also ibid., pp. 259–61, where similar principles are applied to elasticity in general. Marshall's standard treatment is to be found in *Principles of Economics* (8th edition; London: Macmillan, 1920), pp. 385 f.

laws to hold.) The actual derivatives are, however,

$$\frac{\partial\lambda}{\partial\eta} = \frac{ke^2}{[e+\eta(1-k)]^2},$$

$$\frac{\partial\lambda}{\partial k} = \frac{e\eta(e+\eta)}{[e+\eta(1-k)]^2},$$

$$\frac{\partial\lambda}{\partial e} = \frac{k\eta^2(1-k)}{[e+\eta(1-k)]^2}.$$

The first and third of these derivatives have the correct positive sign, confirming Marshall's second and fourth laws. The middle derivative, relating to Marshall's third law, is another matter. It will have the 'wrong' negative sign whenever e, the elasticity of supply of co-operant factors taken together, is negative but smaller in absolute value than η, the elasticity of demand for the product.

We cannot at this late date guess the reason for Marshall's slip in his third law. Conceivably, skilled mathematician though he was, he neglected to test the signs of his derivatives against the language of his text. More probably he thought the matter unimportant, particularly since it is difficult if not impossible to give felicitous literary meaning to our exceptional case, either in our terminology or in Marshall's. Possibly also Marshall felt himself protected sufficiently by the characteristic diffidence with which he stated the general principle in his text. At any rate, difficulty with Marshall's third law inheres in his own algebraic formulation of the elasticity of derived demand, and foreshadows the difficulty encountered by J. R. Hicks with a fuller and more general statement forty-two years after the first edition of the *Principles*.

The Hicks Solution

Part I of Hicks's *Theory of Wages* may be regarded as in large part an extension of the marginal productivity analysis of Marshall and J. B. Clark to take explicit account of measurable substitution, Hicks himself having developed a convenient measure in the elasticity of substitution σ.[1] In

[1] In the notation of n. 1, p. 254, above, the elasticity of substitution between inputs 1 and 2 (denoted by σ_{12}) is defined as:

$$\sigma_{12} = \frac{\partial(x_1/x_2)}{\partial(p_2/p_1)} \frac{(p_2/p_1)}{(x_1/x_2)}.$$

The reduction to the conventional symmetric form:

$$\sigma_{12} = \frac{\dfrac{\partial q}{\partial x_1}\dfrac{\partial q}{\partial x_2}}{q\dfrac{\partial^2 q}{\partial x_1\,\partial x_2}}$$

requires that the production function $q = F(x_1, x_2)$ be linear homogeneous. See the development in R. G. D. Allen, *Mathematical Analysis for Economists* (London: Macmillan, 1938), p. 343.

his Appendix iii, devoted specifically to the elasticity of derived demand, Hicks retraces Marshall's steps with the elasticity of substitution as an additional determining variable. If more general than Marshall in this regard, Hicks limits himself (as Marshall does not) to cases of long-run competitive equilibrium where the production function is linear homogeneous and production is at constant cost.[1] Hicks's expression for the elasticity of derived demand, or λ, is:[2]

$$\lambda = \frac{\sigma(\eta+e)+ke(\eta-\sigma)}{\eta+e-k(\eta-\sigma)}, \tag{2}$$

which reduces to the Marshallian equation (1) when σ is zero.

Of the four Marshallian laws, one comes off better, one worse, and two the same when faced with the derivatives of (2) as compared to (1). The first law can now be tested by taking the partial derivative $(\partial\lambda/\partial\sigma)$; it is confirmed unequivocally. The second and fourth laws are also confirmed unequivocally. The validity of the third law, tested by $(\partial\lambda/\partial k)$, now becomes more suspect than ever. Whether 'it pays to be unimportant' now becomes dependent on the relative values of η and σ, assuming a positive elasticity for the supply of the 'other' factor x_2. When η exceeds σ the law is confirmed, and vice versa, for a positive e. At the same time the validity of the law continues to depend on the sign and size of e when η exceeds σ; it is now disconfirmed when e is negative and between η and σ in absolute value. The four derivatives of (2) are, in the order of Marshall's laws,

$$\frac{\partial\lambda}{\partial\sigma} = \frac{(1-k)(\eta+e)^2}{[\eta+e-k(\eta-\sigma)]^2}, \qquad \frac{\partial\lambda}{\partial\eta} = \frac{k(e+\sigma)^2}{[\eta+e-k(\eta-\sigma)]^2},$$

$$\frac{\partial\lambda}{\partial k} = \frac{(\eta+e)(e+\sigma)(\eta-\sigma)}{[\eta+e-k(\eta-\sigma)]^2}, \qquad \frac{\partial\lambda}{\partial e} = \frac{k(1-k)(\eta-\sigma)^2}{[\eta+e-k(\eta-\sigma)]^2}.$$

The plausibility of the exceptions to Marshall's third law has yet to be

[1] It should be noted that a linear homogeneous production function is not inconsistent with diminishing returns to individual factors of production. For example, the Cobb–Douglas function in its original form:

$$P = bL^kC^{1-k},$$

with k positive but less than unity, yields a marginal product of labour which clearly decreases with L, while the second derivative is correspondingly negative:

$$\frac{\partial P}{\partial L} = \frac{kP}{L}, \qquad \frac{\partial^2 P}{\partial L^2} = \frac{k(k-1)P}{L^2}.$$

The falling marginal productivity of labour implies rising marginal labour and total cost while average cost is constant. At the same time the Cobb–Douglas function is linear homogeneous in that multiplication of L and C by a common factor m will increase P by the factor m as well. Compare Paul H. Douglas, *Theory of Wages* (New York: Macmillan, 1934), p. 156.

[2] The unwary reader is warned that the mathematics of Appendices iii–iv of Hicks's *Theory of Wages* is elliptical and difficult to follow. In checking it through—and finding it correct—the writer acknowledges the assistance of Professor Hicks himself, as well as of Professor Marcel K. Richter of the University of Minnesota.

demonstrated convincingly or even completely in literary terms. Hicks and D. H. Robertson have made attempts.

Hicks, considering a hypothetical case of a factor price increase brought about by supply restriction, translates his mathematics into English:[1]

> . . . if technical change is easy, while the product has an inelastic demand, the rule works the other way. For example, a factor may find it easier to benefit itself by a restriction in supply if it plays a large part in the process of production than if it plays a small part. *It is 'important to be unimportant' only when the consumer can substitute more easily than the entrepreneur.*

Robertson explains the same result along different lines 25 years later:[2]

> . . . if the demand for coal is very inelastic, while hewers can fairly easily be replaced by coal cutting machinery, it *pro tanto* strengthens the position of hewers that their wages should be a large part of total costs. This is not at all easy to see by common sense, but can perhaps be put in this way. In the case supposed, the weak element in the position of the miners is their liability to substitution. But this element of weakness will be the less serious in its consequences the larger is the field over which it has to be applied in order to do them any serious damage, i.e. the larger is the proportion which, to start with, their wages-bill forms of the whole cost of production.

'Common sense' appears to suggest that a high elasticity of demand for the product and a high elasticity of substitution between services should reinforce rather than offset each other in increasing the 'importance of being unimportant'. Hicks, translating his mathematics impeccably, does not come to grips with common sense. The passage from Robertson, which has no direct connexion with the Hicks formula, is more difficult to interpret. It may be appealing against common sense to some *deus ex machina* (such as a shortage of finance) which somehow prevents substitution from operating over a wide field as readily as over a narrow one, or as readily as at the margin. Or more legitimately, Robertson may be implying that the mixed second partial derivative $(\partial^2\lambda/\partial k\partial\sigma)$ is negative, in which case a high k operates technically to reduce the value of σ. In other words, a negative mixed derivative makes it possible for the total derivative $(d\lambda/dk)$ to be negative even though the partial derivative $(\partial\lambda/\partial k)$ is not. (The negative mixed derivative is a possible but not a necessary outcome, unless the elasticity of supply e of co-operant factors is very large.[3]) Neither Hicks nor Robertson considers in this connexion the possibility of a negative e.

[1] Hicks, op. cit., p. 246 (italics in original).

[2] D. H. Robertson, *Lectures in Economic Principles*, vol. ii: Staples, 1958, p. 31.

[3] To differentiate $(\partial\lambda/\partial\sigma)$ of (2) with respect to k is a formidable task as it stands. Let us reduce it to a simpler form:

$$z = \frac{ux^2}{y^2},$$

where u and x are positive, and where u and y are functions of another variable t. In this case:

$$\frac{dz}{dt} = \frac{x^2}{y^3}\left(y\frac{du}{dt} - 2u\frac{dy}{dt}\right).$$

We can say nothing definite about the sign of (dz/dt) even when (as here) we know (du/dt)

The Allen Solution

Whereas both Marshall and Hicks concerned themselves directly with the market demand for productive serives, R. G. D. Allen developed a model of individual demand for these services by a single competitive entrepreneur with a given production function and a given production indifference map.[1] His results are considerably simpler in form than either of the others we have considered:

$$\lambda = (k_1\eta + k_2\sigma), \tag{3a}$$

where k_1 and k_2 are the respective shares of factors 1 and 2 in total cost. If we continue to regard factor 2 as the composite of all co-operant and substitute services, k_2 becomes $(1-k_1)$ or simply $(1-k)$ and we have:

$$\lambda = k\eta + (1-k)\sigma. \tag{3b}$$

Partial differentiation of (3 b) as a test of Marshall's laws yields simple results:

$$\frac{\partial\lambda}{\partial\sigma} = 1-k, \qquad \frac{\partial\lambda}{\partial\eta} = k, \qquad \frac{\partial\lambda}{\partial k} = \eta-\sigma.$$

Marshall's first two laws stand confirmed as in the Hicksian case, while the validity of the third depends again upon the relative sizes of η and σ. Since the elasticity of supply of co-operant factors does not appear in (3), Marshall's fourth law cannot be tested.

An advantage of the Allen formulation (3) is that it permits of literary translation. The elasticity of derived demand for a productive service under competitive conditions depends upon the elasticity of demand for the product and the elasticity of substitution between productive services. The weights of the two determining variables are the respective weights in total cost of the service under consideration and all other co-operant services taken together. The variation of the elasticity of derived demand (λ) for a productive service with the relative weight (k) of that service in total cost is only a side issue. The important role of k is in determining the relative weights of η and σ.

The Allen and Hicks solutions are further related in the following way. Hicks assumed that long-run equilibrium on the product market required

is negative. As e approaches infinity, however, (2) becomes an indeterminate form reducing to:

$$\lambda = k\eta + (1-k)\sigma,$$

for which the mixed derivative $(\partial^2\lambda/\partial k\partial\sigma)$ is necessarily negative. (This point will come up again in the next section.)

[1] Allen, op. cit., pp. 372 f. In addition to the result we have cited, Allen also derives the cross-elasticity of demand for factor 2 in response to a change in the price of factor 1. This cross-elasticity, which we can denote by λ', is in our notation:

$$\lambda' = k(\sigma-\eta).$$

From Allen's mathematical development can also be derived a third elasticity, which we denote by λ^*, of the product price with respect to the price of factor 1:

$$\lambda^*- = k.$$

factor price p_2 to move in the opposite direction from p_1 to maintain average cost equal to product price. This assumption requires consideration of the supply elasticity of the second factor. Allen, on the other hand, maintains long-run equilibrium when p_1 changes by a change in the product price. The other factor price p_2 is held constant and the supply elasticity of factor 2 is not involved.

This constant-price assumption for co-operant factors is applicable not only for the competitive firm (where Allen invokes it) but also for the competitive industry, if the co-operant factors are unspecialized to it. For such a competitive firm or industry the elasticity of supply of factor 2 is in fact infinite. As a test of the consistency of the Hicks and Allen solutions, the Hicks equation (2) reduces to the Allen equation (3 b) when e approaches infinity in (2) and the result is evaluated as an indeterminate form.

In connexion with the Robertson explanation of a negative $(d\lambda/dk)$, it should be noted that in the Allen solution the mixed derivative $(\partial^2\lambda/\partial k\partial\sigma)$ is -1. This necessarily negative number adds to the possible pertinence of Robertson's point.

Summary and Conclusions

We have reconciled and compared, but not developed, three standard formulae for the elasticity of derived demand for a productive service or factor of production under competitive conditions. The Hicks formulation (2) we found most general. The Marshall and Allen formulations (1) and (3) we found to be special cases in which, respectively, the elasticity of substitution was set equal to zero and the elasticity of supply of co-operant factors was set equal to infinity. Let us now restate Marshall's four laws, reconsidering the relevance and validity of each:

Marshall's first law: The larger the elasticity of substitution σ between two productive services, the higher the elasticity of derived demand λ for each of the productive services. True, and relevant whenever substitution is possible.

Marshall's second law: The larger the elasticity of demand η for a commodity, the higher the elasticity of derived demand for all productive services specialized for its production. True.

Marshall's third law: The larger the weight k of any productive service in the total cost of a commodity, the higher the elasticity of derived demand for the service. Not universally true, or particularly important in view of the role of k in determining the relative importance of η and σ in computing λ. The technical validity of this law depends upon the sign of $(\eta-\sigma)$ and on the sign and size of e, the elasticity of supply of

co-operant and substitute services. Specifically, the law is confirmed in three cases:

1. If both $(\eta-\sigma)$ and e are positive.
2. If $(\eta-\sigma)$ is positive, and e is a negative quantity larger than η or smaller than σ in absolute value.
3. If $(\eta-\sigma)$ is negative, and e is a negative quantity lying between η and σ in absolute value.

Marshall's fourth law: The larger the supply elasticity e of substitute or co-operant services the larger is the elasticity of derived demand for any productive service. True, and relevant whenever the other services are so specialized to the firm or industry in question that their combined supply elasticity is less than finite.

Returning to the controversial third law, it is possible to develop at least two reasons for treating it as an acceptable first approximation in most short-run micro-economic problems:

1. Short-run elasticities of substitution between productive services are apt to be low, making $(\eta-\sigma)$ positive.
2. Elasticities of supply of productive services to individual firms and industries are almost certainly positive. Cases of negative elasticity required to overthrow or disconfirm Marshall's third law are all highly unusual.

On the other hand, supply schedules of productive services to firms and industries are often not only positive but elastic enough to make the Allen equations (3) good representations of reality. In this case the mixed derivative $(\partial^2\lambda/\partial k\partial\sigma)$ is necessarily negative. This means that the elasticity of substitution falls with the importance of the productive service in total cost, quite possibly to the point where it is 'important to be important' when it comes to raising the rewards for services by restricting their supply. This provides in our view the largest element of plausibility to the special cases where Marshall's third law breaks down, and we owe its development largely to Robertson.

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MARSHALL'S THIRD RULE: A FURTHER COMMENT

By J. R. HICKS

I AM grateful to Professor Bronfenbrenner for redirecting attention to this funny old paradox, which has gone on worrying people ever since I first put it forward in my juvenile work. There is, I think, no doubt that the mathematics were right; no one has found anything wrong with them in nearly 30 years. But the sense of the conclusion which they appeared to establish was rather lacking, even (I must frankly admit) in the mind of the author himself. Now, however, having had to think the thing through again, I believe I see the answer.

It may first of all be useful to observe that the general formula for the elasticity of demand for a factor of production (in a two-factor industry, with constant returns to scale) which I gave in the Appendix to my *Theory of Wages*, and which is quoted by Bronfenbrenner,[1] reduces to the 'Alien' formula when e (the elasticity of supply of the second factor) is infinite, and to something very similar[2] when $e = 0$. When e is infinite,

$$\lambda = k\eta+(1-k)\sigma, \tag{1}$$

when e is zero,

$$\frac{1}{\lambda} = \frac{k}{\eta}+\frac{1-k}{\sigma}. \tag{2}$$

The *Theory of Wages* formula, which (when one sees this) had obviously better be written

$$\lambda = \frac{\sigma\eta+e(k\eta+\overline{1-k}\sigma)}{(k\sigma+\overline{1-k}\eta)+e}, \tag{3}$$

bridges the gap between the Allen formula (1) and its dual (2).

Whether one looks at (1), at (2), or at (3), the paradox—that λ increases with k only if $\eta > \sigma$—persists. What, however, is the meaning of the condition that $\eta > \sigma$? Put just like that it has no very obvious meaning. σ (the elasticity of substitution) is *a* measure of substitutability between the factors; but (though it has proved, in an immense amount of subsequent work, to be an exceedingly useful measure) it is not the only possible measure of substitutability. I remember, in those very old days, being asked (I think it was by Maurice Allen)—why use σ as your measure of substitutability? Why not use (say) $\overline{1-k}\,\sigma$? I did not then see a clear answer, except (perhaps) to make a possibly irrelevant appeal to symmetry.

[1] His equation (2).

[2] Though it looks like it, this is of course not the same as the Marshall formula, Bronfenbrenner's equation (1).

A few years later I ought to have seen the answer. For if one had been doing that work a few years later, one should have realized that in working out a formula for the elasticity of derived demand (à la Marshall or Pigou) one was not finishing the job. The formula for the elasticity of demand for factor A, against the price of A, ought to have been completed by a formula for the cross-elasticity, of the demand for the other factor B, against the price of A. (I don't think cross-elasticities had been invented when I wrote the *Theory of Wages*.) If one starts from the Allen formula (1), with the price of B held constant, the formula for the cross-elasticity can be written down at once. It is

$$\mu = k(\eta - \sigma), \tag{1'}$$

where μ is the elasticity of the quantity of B against price of A. Corresponding to the dual (2), one must have a formula for the elasticity of the price of B, since the employment of B is now to be fixed; it will make for symmetry if we express this as an elasticity of the price of B against the *supply* of A, the reciprocal of which we will call μ'. It can then be shown that

$$\frac{1}{\mu'} = k\left(\frac{1}{\sigma} - \frac{1}{\eta}\right). \tag{2'}$$

The general relation between μ and μ' is given by

$$\begin{aligned}\mu\mu' &= -(d\log b/d\log p_a)(d\log a/d\log p_b)\\ &= -(d\log a/d\log p_a)(d\log b/d\log p_b) = \lambda e.\end{aligned}$$

The general formula for the effect on the other factor may therefore be written in two alternative forms. We may write it as

$$\mu = \frac{k(\eta-\sigma)e}{(k\sigma+\overline{1-k}\eta)+e} \tag{3'a}$$

if we are interested in the effect of the price of A on the employment of B—this reduces to (1') when e is infinite; or we may write it as

$$\frac{1}{\mu'} = \frac{k(\eta-\sigma)}{\sigma\eta+e(k\eta+\overline{1-k}\sigma)}, \tag{3'b}$$

which reduces to (2') when $e = 0$.

So much for the mathematics. There is just one thing of possible economic importance which emerges from these formulae. The condition $\eta > \sigma$, which caused all the trouble, is the condition for an increase in the *supply* of factor A to increase the *demand* for factor B. With this clue in mind, let us kick down the ladder by which we got up, and see if we can rethink the matter in simpler terms.

It is ordinarily not easy to envisage a process of production with two factors only, such that one is highly substitutable for the other. For we usually think of one factor as employing the other, and the mechanics of

substitution at the expense of an employing factor (when carried to an extreme) may seem a bit mysterious. Let us, however, think of the two factors as two sorts of labour, and suppose (for the present) that there is no other factor used. Let us call them Black Labour and White Labour, which can easily be thought of as close substitutes in one set of conditions, and much less close substitutes in other conditions, very much as we like.

Suppose that White Labour gangs up and raises its wage-rate (in terms of general purchasing power). At a constant wage of Black Labour, the cost of the product is raised and the amount to be produced falls ($\eta > 0$). The demand for White Labour falls, and (if there is no substitution) the demand for Black Labour falls also. But if σ is positive, there are two forces affecting the demand for Black Labour, the diminished demand for the product tending to diminish it, the substitution tending to increase it. Either may be dominant.[1]

First consider the 'ordinary' case, where the elasticity of demand for the product is dominant, so that the rise in the wages of White Labour is bad for Black Labour. It is then maintained that the demand for the White Labour will be more elastic, the larger is its share (k) in the total costs of production: the traditional 'Marshall' view. For White Labour sustains its higher wage, partly at the expense of the consumer, partly at the expense of Black Labour. It is intelligible that White Labour can more easily increase its aggregate wage, the more easily Black Labour can be squeezed. If k is large, $1-k$ (the share of Black Labour) will be small; a relatively small increase in the share of White Labour means a relatively large decrease in the share of Black Labour, which will only come about with difficulty. Thus it is confirmed that in this case it is 'important to be unimportant'.

Now consider the other case, when the elasticity of substitution is dominant. Here, when White Labour pushes up its wage, there is a gain to Black Labour. Some part of what White Labour squeezes out of the consumer has to be handed over to Black Labour. It is now intelligible that if k is large, so that Black Labour's initial share is small, a considerable relative expansion in the total accruing to Black Labour will do relatively little harm to White Labour. That, I think, is what my mathematics were really trying to say.

In order to make sense of my 'paradox', I have had to construct a rather artificial example. That, of course, is why it has so long remained para-

[1] So far I am assuming that the wage of Black Labour (in terms of the same genera purchasing power) remains constant, so that I can simply apply the 'Allen-type' formula (1′). But the condition $\eta \gtrless \sigma$ determines whether the demand *curve* for Black Labour moves the one way or the other, so that it also determines whether the wage of Black Labour rises or falls, when the supply of Black Labour is less than perfectly elastic. This is confirmed by the other formula (2′–3′).

doxical. But having got so far, it is easy to notice that it could easily have been made less artificial—by introducing a third factor. I will not go into the mathematics of that—the idea of doing so is rather terrifying; as usual, they can be avoided. For suppose that there are three factors in our industry—White Labour, Black Labour, and Capital as well. In theory, we can split the process of production up into two stages—in one of which White Labour is combined with Black Labour to make Grey Labour, while in the other Grey Labour is combined with Capital to make the Product.[1] The theory which has been elaborated above can then still be used, but must be used twice: once to derive the demand for Grey Labour from the demand for the Product and the supply of capital, once to derive the demand for White Labour from the demand for Grey Labour and the supply of Black Labour. It still remains true that the demand for White Labour will be more elastic the larger is k, if $\eta > \sigma$; less elastic the larger is k, if $\eta < \sigma$. But η is here the elasticity of derived demand for Grey Labour, σ is the elasticity of substitution between White Labour and Black Labour, k is the proportion of White Labour costs to total *labour* costs, not total costs including capital costs.

I do not see why the 'paradox', in this latter form, should not be acquitted of its paradoxicality, and become quite reasonably useful.

All Souls College, Oxford.

[1] If the three-factor production function exhibits constant returns to scale, the intermediate product (Grey Labour) can evidently be defined so that both of the partial production functions will exhibit constant returns to scale also.

ANOTHER COMMENT

It is nice to meet this old friend again.

I don't think my own attempt to clothe Hicks's mathematical skeleton in words was very successful. But I don't think that in making it I was subconsciously bringing in some third factor such as finance. It is probably nearer the truth that like M. Jourdain I was talking cross-elasticities without knowing it; perceiving dimly that, in the case supposed, the damage done to miners by their liability to substitution would be more *diluted* the larger the field over which the substitution fell to be applied. And this, if I am not mistaken, is what Hicks is now saying, with much greater clarity, at the bottom of p. 264.

There remains one point. In the normal case ($\eta > \sigma$) it is easy to give a literary dress to Marshall's fourth law ($\partial\lambda/\partial e > 0$) in some such way as I have done in my *Lectures* (ii. 30):

> The demand for the labour of the group will be less elastic . . . the less elastic the supply of the other factors—i.e. the readier they are to take reduced rewards without slinking away.

But to cover the case where $\eta < \sigma$, and the demand curve for the other factors therefore raised (p. 264, footnote), we have to add something like the following:

> or the less the prospect of an increased reward causes them to gather like wasps round a patch of honey.

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THE INTERRELATIONSHIP BETWEEN COST AND PRICE CHANGES, 1946–1959

A Study of Inflation in Post-War Britain

By L. A. DICKS-MIREAUX

1. Introduction

This study[1] is concerned with changes in the general level both of wages and of prices during the period 1946–59. It is an attempt to explain, using regression techniques, the way in which they were influenced by the pressure of demand for labour and changes in import prices, and to describe the mutual reaction of prices on wages and of wages on prices.

Most previous empirical studies have been confined to explaining wage changes alone without taking full account of the mutual interaction of wages and prices.[2] It seems possible to get a little further than this by a simultaneous approach, and thereby test hypotheses relating to both the formation of wage changes and of price changes.

Regression techniques provide estimates only of the *short-term* influences on wages or on prices. These estimates need to be set in the context of the long-term development of wages and prices provided by the national income statistics. It then appears that the short-term statistical relationships may not give a complete picture of the cost/price mechanism, but need to be amplified on the grounds of somewhat more general reasoning.

The short-term equations describing wage and price changes imply that a 1 per cent. change in the level of demand for labour—roughly equivalent to a similar change in the percentage level of unemployment—gives rise to an annual rate of change of about 3 per cent. in wages. Similarly a change of 1 per cent. in import prices appears to lead fairly quickly to a change of about ¼ per cent. in final prices. The least certain results

[1] A first version of this paper was read to the Cardiff meeting of the British Association, Sept. 1960. The author would like to thank Mr. J. C. R. Dow for his invaluable comments at all stages in the preparation of this paper, and to thank also Professor A. W. Phillips, Messrs. W. B. Reddaway, C. T. Saunders, and J. R. Shepherd for their comments on an earlier draft.

[2] Some of the recent studies concerned with data for the United Kingdom are:

(i) 'Analysis of the Generation of Price Inflation', by J. C. R. Dow, *Oxford Economic Papers*, Oct. 1956, pp. 252–99.

(ii) 'The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957', by A. W. Phillips, *Economica*, Nov. 1958, pp. 283–99.

(iii) 'The Determinants of Wage Inflation: United Kingdom, 1946–1956', by L. A. Dicks-Mireaux and J. C. R. Dow, *Journal of the Royal Statistical Society*, Series A (General) vol. 122, part 2, 1959, pp. 145–84.

(iv) 'The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1862–1957: A Further Analysis', by R. G. Lipsey, *Economica*, Feb. 1960, pp. 1–31.

concern the estimates measuring the mutual influence of wages on prices and of prices on wages. Finally, the long-term model which is put forward to account for the inadequacies of the short-term results suggests that there may be further, delayed repercussions on wages and prices.

2. The Model and Method

The general hypotheses tested were:

(*a*) Changes in wages and salaries are determined partly by previous price changes, partly by changes in output per man, and partly by the pressure of demand for labour.

(*b*) Changes in prices are determined partly by past changes in labour costs, partly by past changes in import costs and partly by changes in output per man.

Through the mutual reaction of wages on prices and of prices on wages there is some interdependence in the complete system defined by these two hypotheses. Fig. 1 attempts to illustrate this causal set-up schematically.

It is probable that the effect of past changes in the determinant variables on the dependent variable, i.e. wage or price change, is distributed over several years (see p. 284). There may be an initial delay when little or no effect occurs, and then a series of past changes in the determinant variable each exerting some effect. The dependent variable will change in response to the combined influence of past changes in the determinant variables. The separate responses of the dependent variable to a unit change in the determinant variable, lagged at equidistant time intervals are often called the time-shape or time-form of the reaction.[1] In principle an estimate of the time-form of reaction is provided by the regression coefficients of each of the lagged values of the determinant variable.[2] But it would be difficult to allow for all the lagged determinant variables: the number of observed annual changes is far too small for such sophistication, since the analysis has been confined to fourteen post-war years. This being so, one of two solutions remains open. The first is to

[1] See, for example, L. M. Koyck, *Distributed Lags and Investment Analysis*, North-Holland Publishing Co., Amsterdam, 1954; and 'Some Notes on the Estimation of Time-Forms of Reactions in Inter-dependent Dynamic Systems', by A. W. Phillips, *Economica* (N.S.), no. 90, May 1956, pp. 99–113.

[2] This may be better seen if set out formally: if y is the dependent variable and x the determinant or independent variable the relationship described above may be written as:

$$y_t = a_0 x_t + a_1 x_{t-1} + a_2 x_{t-2} + \ldots + a_n x_{t-n},$$

or

$$y_t = \sum_{i=0}^{n} a_i x_{t-i}.$$

It follows that, in principle, the pattern described by the a's, called the time-form of reaction, can be estimated by multiple regression methods.

assume, *a priori*, the shape of the time-form and calculate a composite determinant variable based upon current and lagged observations of it. But since there are few clues about the shape of the time-form, a second solution was adopted. This consisted of estimating first the *short-term* relationships only, that is, changes from one year to the next. In this way it seemed possible to isolate the major reaction, that is, the modal value of the time-form (Fig. 1).

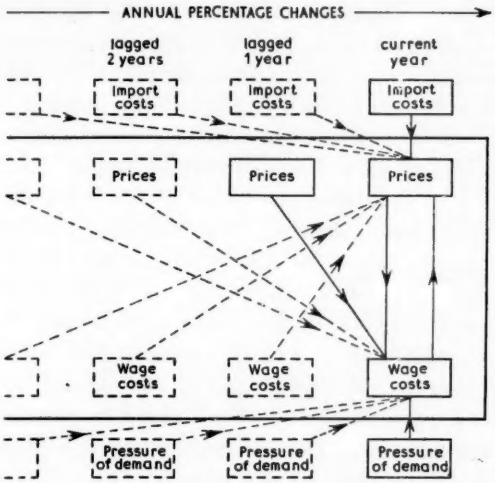

FIG. 1

Consequently, only recent past changes in explanatory variables have been considered[1] (the parts drawn in bold lines in Fig. 1). By the more general argument of section 5 the analysis is taken further to suggest a plausible general interpretation of the data for the post-war period.

These short-term relationships may be expressed formally as:

$$W_t = a+bP_{t-\theta}+cD_{t-\lambda}+fX_t+u_t \qquad (1)$$

and

$$P_t = g+kW_{t-\mu}+mI_{t-\tau}+nX_t+v_t, \qquad (2)$$

where the following notation has been used:

W = average wages and salaries per person employed: annual percentage change between twelve-month averages.

P = final (factor-sale) prices: annual percentage change between twelve-month averages.

D = pressure of demand for labour:[2] annual percentage level.

[1] The assumption is made here that the time-form is skew so that the modal value will correspond to the most recent past change in the explanatory variable.

[2] See 'Excess Demand for Labour', by J. C. R. Dow and L. A. Dicks-Mireaux, *Oxford Economic Papers*, Feb. 1958, pp. 1–33; and the *National Institute Economic Review*, Appendix,

I = import prices: annual percentage change between twelve-month averages.

X = output per man: annual percentage change between twelve-month averages.

u, v = error terms.

t = time subscript measured at yearly intervals.

$\theta, \lambda, \mu, \tau$ = initial delay periods measured in yearly units.

W and P are endogenous variables in the short-term wage/price mechanism described by the structural equations (1) and (2), and all other variables are considered here to be exogenous. A full description of the series underlying these variables is given in Appendix A.

In the short-term relationships time-lags correspond to the interval between the modal reaction of the explanatory variable and the subsequent adjustment to it of the dependent variable. They are therefore referred to here as 'initial delay periods'. Thus the lagged response of a wage change, for example, to a price change implies that prices have little or no effect on wages for a period of some months. Experiment with different initial delay periods for both equations (1) and (2) showed that these periods were not considerable and were in all cases less than 1 year (see p. 275). The period (θ) between the wage change and the determinant price change in equation (1) appeared to be between 3 and 6 months, and the interval (μ) between a wage change and the dependent price change in equation (2) appeared to fall between 0 and 3 months.

These initial delays are important, for they determine the degree of interdependence of the short-term relationships. Price and wage changes have been measured annually, only because they are not generally available for shorter intervals. But since the interval (θ) between a given price change and the wage change it partly determines, plus the interval (μ) between this wage change and the price change it in turn causes, is less than 1 year, part of the initiating price change will be common to the final price change. In other words, neither the determinant price change and the determined price change, nor the determinant wage change and the determined wage change are independent.

This phenomenon of feedback means that neither equation (1) nor (2) may be properly estimated singly by the method of least squares, for in these circumstances the estimated regression coefficients of price change (in equation (1)) and of wage change (in equation (2)) would tend to be

table 3. Changes in the index of the pressure of demand are broadly similar to changes in the percentage level of unemployment. The average level of unemployment associated with the zero point of the index has been between 1·5 and 1·6 per cent. during the period 1946 to 1959. The index standing at zero does not necessarily imply that the overall supply of, and demand for, labour are 'in balance'. But it does imply a level of unemployment which does not in itself exert a *short-term* pressure on wages.

biased. An estimation procedure for overcoming this risk is provided by the 'two-stage least squares method' developed by Theil.[1] Appendix B outlines the method in formal terms so that only a brief description is given here. The source of interdependence in the short-term wage/price mechanism stems from the endogenous variables, wage and price changes. But with some slight modifications the two structural equations (1) and (2) may be recast to give the *reduced form* equations in which each endogenous variable is expressed as a function of exogenous or predetermined variables only. Applying the method of least squares to each of these reduced form equations, calculated, as distinct from observed, values may be obtained of wage and price changes which will be devoid of any feedback element. This is the first stage. These calculated changes may now be substituted as explanatory variables into each of the structural equations (1) and (2). At this second stage the method of least squares may again be applied—this time to each structural equation—to obtain unbiased estimates of the structural coefficients.

The approach in this study has been to experiment with various forms of the structural equations estimated by what might be called the single-stage least squares method, the risk of biased estimates being taken in order to isolate the preferable *form* of each equation. The two-stage least squares method was then used to obtain unbiased estimates of the parameters.

3. The Short-term Relationships: Statistical Results

The five equations, three estimated by the single-stage least squares method, and two by the two-stage least squares method, which accounted for most of the variation in wage and price changes during 1946 and 1959, are:[2]

(*a*) Single-stage Least Squares

$$W(t) = \underset{}{4{\cdot}07} + \underset{(0{\cdot}37)}{0{\cdot}41}P(t-\tfrac{1}{4}) + \underset{(0{\cdot}08)}{2{\cdot}60}D(t-\tfrac{1}{4}) + \underset{(0{\cdot}49)}{u(t)} \qquad (3)$$

$$R^2 = 0{\cdot}91$$

[1] A general description of the method of two-stage least squares is given in *Economic Forecasts and Policy*, by H. Theil, North-Holland Publishing Company (Amsterdam, 1958), pp. 334–61. The present analysis is a simple application of this method. The two-stage least squares method is not, of course, the only procedure available for estimating interdependent systems for it is more usual to employ techniques based upon maximum likelihood methods. It is preferred here because of its computational simplicity.

[2] Following the usual practice an estimate of the standard error of each estimated coefficient is shown in parentheses beneath the estimate in question. However, in none of these equations can the standard errors be assumed to have been properly estimated so that conventional tests of significance cannot be applied. No test was made for autocorrelation in the residuals, mainly because of the relatively few observations available.

$$W(t) = \underset{(0\cdot51)}{3\cdot72} + \underset{(0\cdot11)}{0\cdot38}P(t) + \underset{(0\cdot08)}{0\cdot14}P(t-1) + \underset{(0\cdot66)}{2\cdot44}D(t-\tfrac{1}{4}) + u(t) \qquad (4)$$

$$P(t) = \underset{(1\cdot03)}{1\cdot95} + \underset{(0\cdot15)}{0\cdot35}W(t) + \underset{(0\cdot03)}{0\cdot20}I(t-\tfrac{1}{4}) - \underset{(0\cdot14)}{0\cdot52}X(t) + v(t) \qquad (5)$$

$$R^2 = 0\cdot95$$

(*b*) **Two-stage Least Squares**

$$W(t) = \underset{(0\cdot63)}{3\cdot90} + \underset{(0\cdot13)}{0\cdot30}P(t) + \underset{(0\cdot10)}{0\cdot16}P(t-1) + \underset{(0\cdot82)}{2\cdot78}D(t-\tfrac{1}{4}) + u(t) \qquad (6)$$

$$P(t) = \underset{(1\cdot39)}{2\cdot47} + \underset{(0\cdot04)}{0\cdot27}W(t) + \underset{(0\cdot04)}{0\cdot21}I(t-\tfrac{1}{4}) - \underset{(0\cdot16)}{0\cdot54}X(t) + v(t) \qquad (7)$$

As the last two equations were simultaneously estimated a measure of the extent to which they jointly account for the variation in wage and price changes was calculated. Known as the coefficient of simultaneous correlation,[1] it is analogous to the ordinary multiple correlation coefficient and for the two estimated equations was equal to 0·99. For the purposes of the two-stage least squares method the original short-term equations (1) and (2) had to be modified slightly. Hence equation (4) contains the current price change and the price change lagged 1 year as explanatory variables instead of the single price change lagged 3 months,[2] and equation (6) is the corresponding equation jointly estimated with the price relationship (7).

The reason for jointly estimating the short-term wage and price relationships was to avoid biased estimates of the regression coefficients attached to the endogenous variables—wage and price changes—when they appeared as explanatory variables in the structural equations. But comparison of the coefficients of the current price change in equations (4) and (6) and of the coefficients of the current wage change in equations (5) and (7) do not suggest the presence of any marked bias. This validates the procedure, discussed below, of experimenting with ordinary least squares methods on the single equations before combining the preferred

[1] Various measures have been suggested in, for example, H. Theil, op. cit., p. 347, and 'Simultaneous Equations and Canonical Correlation Theory' by J. W. Hooper, *Econometrica*, vol. xxvii, no. 2 (April 1959), pp. 245–56. The particular measure adopted here is defined by:

$$(1-S^2) = (1-R_1^2).(1-R_2^2),$$

where S is the coefficient of simultaneous correlation, and R_1 and R_2 are the multiple correlation coefficients of the two reduced forms. It is worth noting that S, as defined, will be close to unity even if the disturbances in the reduced form are large.

[2] A non-integral time-lag of one quarter represents the annual percentage change between the average price level in a year lagged 3 months (October to September) and the average price level in the previous year lagged 3 months. For example, if $P_t(\mathrm{I})$ represents the price index for the first quarter in year (t), then:

$$P(t-\tfrac{1}{4}) = \left(\frac{(P_t(\mathrm{II})+P_t(\mathrm{III})+P_t(\mathrm{IV})+P_{t-1}(\mathrm{I})}{P_{t-1}(\mathrm{II})+P_{t-1}(\mathrm{III})+P_{t-1}(\mathrm{IV})+P_{t-2}(\mathrm{I})} - 1\right) \times 100.$$

Such lags were allowed for in a similar way with other variables.

forms for joint estimation. It seems probable that feedback is relatively unimportant in the aggregate wage/price mechanism described by the model, at least as far as these observations relating to the post-war period are concerned.[1]

The immediate implications of the short-term relationships may be summarized as follows:

(*a*) The Wage Equation

(i) The short-term effect of a change in prices is about one-third of the price change.

(ii) The level of demand plays an important role in the determination of wage changes. A 1 per cent. point change in the level of demand is associated with a change of about $2\frac{3}{4}$ per cent. in the annual percentage rate of wage change.

(iii) The constant term implies that wages will increase at a steady annual rate if prices do not change and if the index of demand is zero.

(*b*) The Price Equation

(i) A change in wages has an immediate short-term effect on the price change; this effect is about one-third of the wage change.

(ii) A change in import prices is also associated with a change in final prices, the effect, after a delay of three months, being about one-fifth of the import price change.

(iii) Changes in output per man also influence changes in prices: about one-half the current change in output per man is reflected inversely in the current price change.

(iv) As with the wage equation, there is a constant term which implies that prices will rise at a steady annual rate if wages, import prices, and output per man do not change.

The jointly estimated equations (6) and (7) are shown in Figs. 2 and 3, which compare the observed and calculated wage and price changes and give the contributions to these changes of the determinant variables. These are only the short-term relationships incorporating time-lags which represent the initial delay periods. The complete time-lags are considered later in section 5.

The reliability of these results is best judged from equations (6) and (7).[2] The standard errors of the price coefficients (in the wage equation

[1] In an earlier paper by Dicks-Mireaux and Dow, loc. cit., it was tentatively argued that over the earlier part of this period 1946–52 import changes were the main determinant of price changes, so that the feedback element through the mutual reaction of wages on prices would be small. The present results seem to support this belief.

[2] It must, however, be emphasized that any attempt to assess the significance of the

(6)) and of the wage coefficient (in the price equation (7)) suggest that the estimates of both these coefficients are somewhat imprecise. This is not surprising. These endogenous variables are the source of interdependence in the system so that precise estimates of the internal links are unlikely. On the other hand, the relatively small standard errors of the coefficients of the remaining, exogenous, variables suggest that the

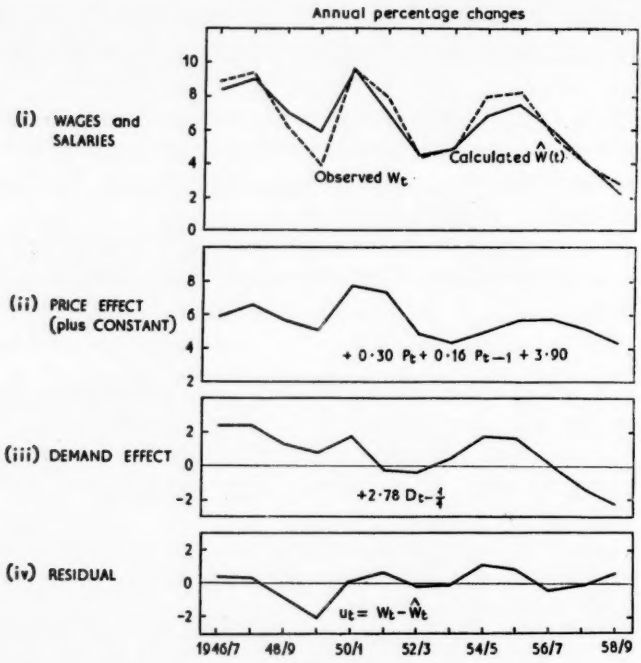

FIG. 2

external links are fairly well determined. In so far as the wage/price complex can be thought of as a single entity, the influence of these exogenous variables is perhaps the most important effect to estimate.

Variants of the Short-Term Relationships

In the preliminary stages of working, different time-lags or initial delay periods were experimented with in both the wage and price relationships. Also the basic hypotheses were varied slightly and different variants

estimated regression coefficients can only be tentative at best. The deliberate exclusion of lagged explanatory variables from the short-term relationships gives strong grounds for suspecting auto-correlation in the residuals of the estimated equations (see in particular p. 109 of the article by A. W. Phillips, referred to on p. 268, n. 1, where this result is formally demonstrated). Consequently the estimated standard errors of the coefficients may contain considerable bias, although the coefficients themselves may be unbiased.

were tested; and in particular the direct effect of changes in output per man on wages was examined.

(*a*) The Wage Equation

Initial Delay Periods. The results obtained by allowing for different delay periods in the wage equation (3) are set out in Table I.

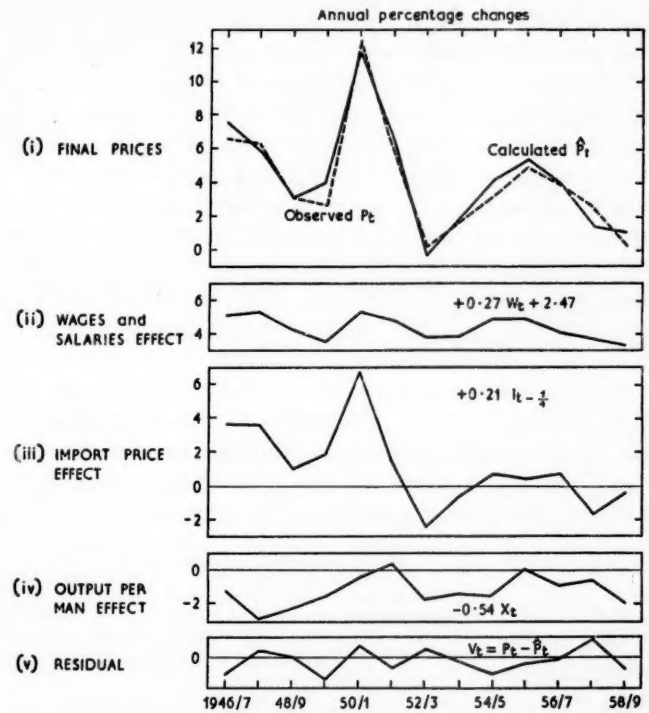

FIG. 3

The effect of increasing the delay period is to reduce the coefficient (*b*) of price change and to increase considerably the demand coefficient (*c*). The constant term (*a*) also becomes larger with longer delays. Since these equations have been estimated independently of the price relationship, the value of the multiple correlation coefficient (R^2) is not strictly correct. None the less the estimated values permit the inference that there is an interval of between 0 and 6 months before the wage change responds either to a price change or to the pressure of demand.

Output per Man. In the original hypothesis (equation (1)) it was thought that changes in output per man would influence wage changes.

TABLE I

Effect of Different Initial Delay Periods: the Short-term Equation for Wages and Salaries, 1946–59

Initial delay periods (months) for:		*Estimated regression coefficients of:*			*Percentage of variation accounted for:* $100R^2$
Price changes $P(t-\theta)$	*Pressure of demand* $D(t-\lambda)$	*Price changes* b	*Pressure of demand* c	*Constant term* a	
1. *Equation (3)*					
(i) 3	3	0·41	2·60	4·07	91·2
2. *Variants*					
(i) 0	0	0·44	1·89	4·25	81·4
(ii) 3	6	0·37	2·59	4·19	87·0
(iii) 6	6	0·27	3·18	4·43	81·2
(iv) 9	6	0·17	3·63	4·72	75·5

Note: Standard errors have not been shown because of their dubious value. For equations other than the first, the standard errors were of the following orders of magnitude:

Coefficient	b	c	a
Standard error	0·1	0·7	0·5

TABLE II

Effect of Productivity Changes: the Short-term Equation for Wages and Salaries, 1946–59

$$W(t) = a+bP(t-\tfrac{1}{4})+cD(t-\tfrac{1}{4})+fX(t)+u(t)$$

Explanatory variables	*Estimated regression coefficients of:*				*Percentage of variation accounted for:* $100R^2$
	Output per man changes f	*Price changes* b	*Pressure of demand* c	*Constant term* a	
1. X = *Output (G.D.P.) per man*					
(i) $X(t)$	−0·25	..	..	7·03	3·3
(ii) $P(t-\frac{1}{4})$	..	0·61	..	3·89	66·3
(iii) $D(t-\frac{1}{4})$	..	..	3·78	5·53	67·3
(iv) $X(t)$ and $P(t-\frac{1}{4})$	0·29	0·68	..	2·92	70·1
(v) $P(t-\frac{1}{4})$ and $D(t-\frac{1}{4})$	..	0·41	2·60	4·07	91·2
(vi) $X(t)$, $P(t-\frac{1}{4})$ and $D(t-\frac{1}{4})$	−0·03	0·40	2·66	4·20	91·3
2. X = *Industrial output per man*					
(i) $X(t)$	−0·13	..	..	6·84	2·9
(ii) $X(t)$ and $P(t-\frac{1}{4})$	0·17	0·68	..	3·11	70·2
(iii) $X(t)$, $P(t-\frac{1}{4})$ and $D(t-\frac{1}{4})$	0·02	0·43	2·55	3·97	91·3

Note: Although no standard errors are shown, it is worth noting that for changes in output per man the standard error was as large as the estimated coefficient when price change ($P(t-\frac{1}{4})$) and productivity change ($X(t)$) were the only explanatory variables, and much larger than the estimated coefficient in all other cases. For the coefficients of the other variables the standard errors were roughly the same as those shown in equation (3).

In fact this variable was found to contribute very little to the estimated wage equation. Table II presents the results obtained including and excluding output per man as an explanatory variable.

Two measures of output per man were used: gross domestic product per employee and industrial production per employee in industry. The results are very similar whichever measure is adopted. Only current changes in output per man were considered as an explanatory variable in Table II.

Changes in output per man add very little to the explanation of wage changes (Table II). The correlation between the two variables taken alone is negligible. Some slight contribution is found when changes in output per man are included jointly with price changes as explanatory variables. But if price changes and the pressure of demand are taken as explanatory variables the further inclusion of changes in output per man contributes practically nothing to the amount of variation in wage changes accounted for; and the coefficient of changes in output per man becomes negligible. No doubt this effect reflects some correlation between changes in output per man and the pressure of demand; but in fact—as might indeed be expected—this is not strong. On the basis of the results in Table II there seems to be little evidence that current changes in output per man directly determine *short-run* wage and salary changes.[1]

Additional Explanatory Variables. Further possible variants of the short-term wage equation were considered. The method, a somewhat crude one, consisted of correlating the residuals of equation (3) with various additional variables. The following results were obtained:

Additional variable	*Correlation coefficient*
Changes in:	
Overtime	−0·07
Consumer market prices (relative to final prices)	−0·13
Retail prices (relative to final prices)	0·08

The lack of correlation between the residuals of the wage equation and changes in overtime is somewhat surprising and must remain, in this analysis, unexplained. The remaining two additional variables were considered since it is likely that wages are most influenced by changes in consumer market prices[2] or by changes in the official retail price index.

[1] Residuals of the estimated wage equation (3) were also correlated with changes in industrial output per man lagged 3 months, 6 months, 9 months, and 1 year. In none was any marked correlation detected. Also the same process was repeated for all the estimated wage equations shown in Table I, and once again no marked correlation was observed. These tests are not completely conclusive, but in the absence of a more exhaustive analysis they provide strong evidence that changes in output per man do not play an important role in the direct short-run determination of wage and salary changes. (This conclusion is further strengthened by the preliminary results of an analysis of changes in wage drift during the post-war period which is being made at the National Institute.)

[2] The average value of consumers' expenditure on goods and services at market prices.

However the correlation coefficients obtained do not suggest that the substitution of final prices by either index of consumer prices would materially alter the explanation of wage changes.[1]

The Price Equation

Initial Delay Periods. As a first step, changes in output per man were omitted from the short-term price equation, since it is not clear how changes in output per man influence price changes and whether their effect can be distinguished from the influence of demand. With this form of the equation, different initial delay periods were experimented with. The results, estimated independently of the wage equation, are given in Table III.

TABLE III

Effect of Different Initial Delay Periods: The Short-term Equation for Changes in Final Prices, 1946–59

Initial delay periods (months) for:		*Estimated regression coefficients of:*			*Percentage of variation accounted for:*
Wage and salary changes $W(t-\mu)$	*Import price changes* $I(t-\tau)$	*Wage and salary changes* k	*Import price changes* m	*Constant term* g	$100R^2$
1. *Equation (5) (excluding output per man)*					
(i) 0	3	0·49	0·18	−0·02	88·0
2. *Variants*					
(i) 0	0	0·71	0·13	−1·20	84·2
(ii) 0	6	0·39	0·20	0·42	85·4
(iii) 0	9	0·83	0·09	−1·73	73·9
(iv) 3	6	0·09	0·25	2·13	82·8
(v) 3	9	0·44	0·14	0·42	59·9

Note: Standard errors are not shown because of their dubious value. In nearly all cases they were fairly low for the estimated coefficient of import price changes (k), but for the estimated constant term they were as large or larger than the constant itself.

These results are somewhat more erratic than those obtained for the short-term wage equation. In particular the estimated value of the coefficient of wage changes fluctuates quite considerably with different initial delay periods. Broadly the values of R^2 suggest delay periods of between 0 and 3 months for the wage change and between 0 and 6 months for the change in import prices. The estimated constant term also varies sharply with the delay period. In so far as it is negative it may provide a hint that changes in output per man should be taken into consideration. But

[1] In each case deviations between changes in the consumer price series and changes in the final price series were correlated with the residuals of the wage equation (3).

before introducing such changes as an explanatory variable, it is necessary to test whether the level of demand and not the change in output per man contributes materially to the explanation of price changes. There is unfortunately no good indicator of the level of demand (in relation to supply) for goods and services; but a proxy measure is perhaps provided by the index of the pressure of demand for labour. As a first test, therefore, the residuals of the first price equation in Table III, were correlated with (i) the current pressure of demand for labour, and (ii) the current change in output per man. The correlation coefficients obtained were:

Additional variable	*Correlation coefficient*
Pressure of demand for labour . . .	−0·41
Change in output (G.D.P.) per man . .	−0·75

The pressure of demand for labour is not highly correlated with the residuals;[1] and in any case the negative sign is not what would be expected. On the other hand, the correlation coefficient with changes in output per man suggests that this variable exerts a strong and inverse influence on price changes.[2]

Output per Man. When output per man was included as an explanatory variable in the short-term price equation, various initial delay periods were again experimented with. The results are shown in Table IV.

The introduction of changes in output per man makes a definite contribution to the amount of variation in price changes accounted for. The extent of this contribution is shown in Table V (which compares the results of Tables III and IV).

Although it was not possible to experiment thoroughly with different initial delay periods in output per man changes, the first equation in which this variable is unlagged is perhaps to be preferred. The residuals of this equation were once again compared with the current values of the index of the pressure of demand for labour, but still no marked association was apparent.

(*c*) The Combined Wage and Price Equations

So far the testing of alternative hypotheses has not been strictly correct, because, by the approach adopted, each short-term equation was estimated singly without taking into account a counterpart price or wage equation. Two of the 'extra' variables seemed sufficiently important to be reconsidered at this stage. Thus (current) changes in output per man were

[1] The conventional significance test, not strictly appropriate here, shows that the correlation coefficient is not significantly different from zero.

[2] It is perhaps worth noting at this stage that changes in output per man bear little relationship to the pressure of demand which represents a *level* not a change. The coefficient of correlation between these two is as low as +0·22.

TABLE IV

Effect of Changes in Output per Man: the Short-term Equation for Changes in Final Prices, 1946–59

Initial delay periods (months) for changes in:			*Estimated regression coefficients of:*				
Wages and salaries $W(t-\mu)$	*Import prices* $I(t-\tau)$	*Output (G.D.P.) per man* $X(t)$	*Wage and salary changes* k	*Import price changes* m	*Output per man changes* n	*Constant term* g	*Percentage of variation accounted for:* $100R^2$
1. *Equation (5)*							
(i) 0	3	0	0·35	0·20	−0·52	1·95	95·2
2. *Variants*							
(i) 0	6	0	0·30	0·20	−0·43	2·04	90·5
(ii) 0	9	0	0·80	0·08	−0·34	−0·76	77·0
(iii) 3	9	3	0·30	0·20	−0·28	1·64	75·1
(iv) 3	12	3	0·98	0·03	−0·21	−1·99	60·2

Note: As in previous tables the standard errors of the estimated coefficients are not shown. For all variables, except changes in output per man, the standard errors of the estimated coefficients were similar to those indicated in the note to Table III. For the coefficient of changes in output per man the standard errors ranged between 0·15 and 0·40, increasing as the initial delay periods increased.

TABLE V

The Contribution of Changes in Output per Man to the Explanation of Changes in Final Prices, 1946–59

Initial delay period (months) for changes in:			*Percentage of variation accounted for:*	
			Changes in output per man:	
Wages and salaries	*Import prices*	*Output per man*	*Excluded*	*Included*
0	3	0	88·0	95·2
0	6	0	85·4	90·5
0	9	0	73·9	77·0
3	9	3	59·9	75·1

Note: Quarterly series of output (G.D.P.) were not available for the full period 1946–59. In order to experiment with lagged productivity changes all other variables were taken with a lead on the annual changes in output per man, for example, $P(t+\frac{1}{4})$ with $X(t)$ gave productivity lagged 3 months. This means, however, that the comparison in the last line of this table is not strictly correct.

correlated with the residuals of the *jointly estimated* wage equation (6); and the (current) pressure of demand for labour was correlated with the residuals of the *jointly estimated* price equation (7). The scatter diagrams are given in Figs. 4 and 5. Fig. 4 still shows the somewhat surprising lack of association between the wage equation residuals and changes in output per man (the correlation coefficient is −0·26). The influence of the level of demand,

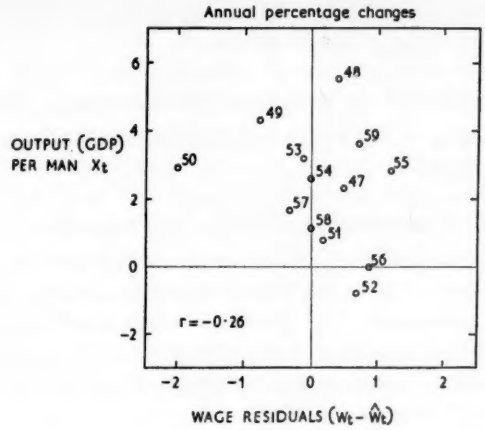

FIG. 4

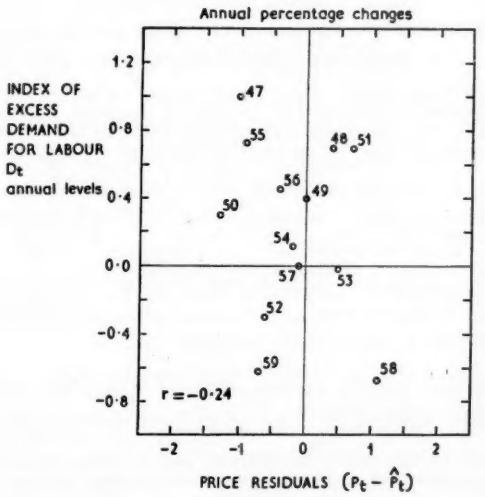

FIG. 5

as approximated by the index used, on price changes also seems to be negligible in Fig. 5 (the correlation coefficient is −0·24.) The conclusion is that the estimated equations (6) and (7) seem the best description of the short-term changes in the wage/price mechanism.

The finding that only about one-half of the current change in output per man is reflected in the current price change may appear surprising. The explanation may be that entrepreneurs base prices not simply on the level of costs in the current year, but on the level expected over a somewhat longer term. This hypothesis, which may be called the 'standardized

costs' hypothesis, is consistent with the present results; but it is not properly tested in the present paper.[1]

4. Comparison with Previous Results

The present results for the short-term equations may be compared with two earlier sets of results.

Previous Study of Determinants of Wage-rate Changes

This attempt to consider jointly the determinants of changes in wages and in prices grew out of an earlier study, which dealt only with wage-rate changes in the post-war period.[2] Since the earlier model for wage-rate changes and the present model for average wage and salary changes are virtually of the same form, the estimated effects of similar explanatory variables are directly compared in Table VI.

TABLE VI

Estimated Coefficients in the Explanation of Wage-rate Changes and of Wage and Salary Changes

Explanation of percentage changes in:	*Sample period*	*Price coefficient*	*Demand coefficient*	*Constant term*
Wage-rates . . .	1946–56	0·54	2·62	1·9
Wages and salaries* .	1946–59	0·41	2·60	4·1
Wages and salaries† .	1946–59	0·46	2·78	3·9

* Single-equation least squares estimates given in equation (3).

† Two-stage least squares estimates given in equation (6). The price coefficient shown here is the sum of the coefficients for current price changes and for price changes lagged one year.

The price and demand coefficients are remarkably similar and only the constant terms differ markedly. This is perhaps not surprising. The

[1] This hypothesis has been suggested privately by W. Godley of the Economic Section of the Treasury. In the long-term relationship suggested later (section 5 below), the lagged values of costs and output per man in the current and several past years are suggested as an explanatory variable for prices. This may be interpreted as a closer statistical proxy for expected costs.

[2] L. A. Dicks-Mireaux and J. C. R. Dow, op. cit. In this paper quarterly changes in aggregate wage-rates during the post-war period were shown to depend upon previous price changes, the level of excess demand for labour and some constant factor. Although the model adopted was non-linear, the range of percentage changes was such that it can be expressed fairly reasonably as a linear one comparable to the present analysis. Thus the estimated relationship accounting for quarterly wage-rate changes between 1946 and 1956 may be written approximately as:

$$W_t = 1{\cdot}9 + 0{\cdot}54P_{t-\frac{1}{2}} + 2{\cdot}62D_{t-\frac{1}{2}},$$

where W = annual percentage change in the aggregate weekly wage-rate index.
P = annual percentage change in the retail price index.
D = annual level of the index of excess demand for labour.

difference between wage-rates and average wages and salaries consists of two elements: first, the gap between wage earnings and wage rates, second, salaries. Apart from fluctuations in overtime earnings the first element is wage drift. Most studies of wage drift in the United Kingdom tend to show that the degree of correlation with price changes and the level of demand is slight.[1] But between 1946 and 1959 weekly wage earnings have increased at an annual rate of 6·5 per cent. compared to 4·9 per cent. for weekly wage-rates.[2] Thus the difference of 1·6 per cent. between these two rates of increase would help to explain most of the difference between the constant terms associated with the earlier explanation of wage-rate changes and the present one concerned with average wages and salaries. There is insufficient information to consider in any detail the effect of the inclusion of salaries in the equation; changes in the rate of increase of salaries are probably less than those in wages, so that the constant term would tend to increase. The present results therefore seem consistent with those of the previous wage-rate study.

Klein's Study of Wage and Price Changes

The only other attempt to consider wages and prices simultaneously for the United Kingdom is that by Klein and his colleagues.[3] Their analysis deals primarily with the *level* of prices and the *level* of wage earnings, so that comparison is not always straightforward. Nevertheless the conclusions drawn differ from the results presented here. Perhaps the two most distinctive features of Klein's analysis are (*a*) the price coefficient in the wage-rate equation, and (*b*) the role of productivity in the wage/price complex.

In Klein's model the estimated effect of price changes on wage changes is invariably greater than any of the estimates put forward here, and in

[1] Preliminary results of an analysis of wage drift during the post-war period also tend to support this conclusion.

[2] These percentages have been based on the Ministry of Labour's earnings inquiries for Oct. 1946 and Oct. 1959. They refer to 'principal industries', which account for some 60 per cent. of operatives in the civilian labour force.

[3] See *An Econometric Model of the United Kingdom*, by L. R. Klein, R. J. Ball, A. Hazlewood, and P. Vandome, Blackwell (1961), pp. 114–26, and Appendix III. The specific question of wage and price determination was also discussed in an earlier paper by L. R. Klein and R. J. Ball, 'Some Econometrics of the Determination of Absolute Prices and Wages', in *Economic Journal*, vol. lxix, Sept. 1959, pp. 465–82. In both these works the model describing the wage/price complex consists of four equations:

(i) Changes in wage rates explained by price changes, the level of unemployment, and a political factor.

(ii) The difference between the level of wage earnings and the level of wage-rates explained by the level of hours and of industrial output per man-hour.

(iii) The level of prices explained by the level of wage earnings, of import prices, and of indirect taxes.

(iv) The level of prices explained by the level of wage earnings, of import prices, and of indirect taxes.

the equation finally adopted is of the order of 0·8. This higher figure does not appear to be the result of more sophisticated estimation techniques. None the less the estimate is a fairly unstable one, considerably influenced by the time-lags attributed to the effect of demand, and once again illustrates the difficulty of obtaining precise estimates of the internal links in the wage/price complex (see also p. 275).

A puzzling feature of the wage/price system as estimated by Klein is the role attributed to productivity. While no such variable appears in the price equation, it is included as a determinant of the level of wage earnings.[1] Thus, it is implied that a rise in productivity leads to a *rise* in prices. It is true that when changes in wage earnings are considered, the productivity effect appears insignificant;[2] but since the price equation makes no specific provision for productivity, this still implies that the effect of productivity on the wage/price system is zero. The correlation between changes in output per man and changes in prices was so markedly negative in the present study (see p. 279) that Klein's results remain all the more puzzling. But Klein's model aims to account for quarterly changes in prices; and it is possible that such very short-term changes in productivity have little or no effect on price determination.

5. The Long-term Implications of the Statistical Results

The two estimated wage and price equations (6) and (7) illustrated in Figs. 2 and 3 describe the responses of wages and prices only to the fairly immediate changes in the determinant variables. It is only these immediate reactions that can be estimated, using multiple regression methods on the limited number of observations available. But they do not necessarily provide a complete picture of the wage/price mechanism; and something more can be learned by comparing the results with what is known about the behaviour of wages and prices over several decades.

An indication of the way wages and prices have developed in the long run is provided by:

(*a*) Official national income figures, available since 1938, and
(*b*) some previous studies based upon less reliable earlier estimates of national income and its components.[3]

These figures show that there has been no large cumulative shift in the

[1] More precisely, the level of output per man-hour in the industrial production index industries is a determinant of the spread between the level of wage earnings and the level of wage-rates, i.e. their difference.

[2] See Klein *et al.*, op cit., particularly Appendix III.

[3] See, for example, 'The Share of Wages in National Income', by E. H. Phelps Brown and P. E. Hart, *Economic Journal*, June 1952, pp. 251–77. From this article the share of wages and salaries in home-produced national income can be derived for each year from 1870 to 1938.

share of wages and salaries in national income. Thus, *in the long run* the change in real wages/salaries has been equal to the change in productivity.

As estimated, the two short-term relationships are not inconsistent with stability of wage and profit shares. Nevertheless, the sizeable constants which appear in both equations, as estimated, are difficult to interpret. As they do not depend on the original hypotheses, some economic meaning has now to be found for them. They may, alternatively, be interpreted as:

(*a*) An institutional, bias creating general pressure for wage increases: for example, some kind of wage push, or, for the price equation, a built-in tendency to raise prices, or as

(*b*) the average values of *delayed* responses to the explanatory variables, i.e. delayed effects of price changes on wages, or of cost changes on prices, which could not be included in the analysis of a short period such as 1946–59. (It could also be argued that the sustained high level of demand in the post-war period may account for these positive constants.)

On the first hypothesis, the constancy of shares in the national product would be an accident. The constancy of shares in the national income can more plausibly be taken as suggesting that in the long run changes in costs are fully passed on as price changes and that profit mark-ups are constant. This being so, the long-run coefficients of wage costs and import costs must sum to unity. As to their separate absolute values, an estimate can be inferred from the post-war detailed national income estimates.

For the period 1946–59 the average share of labour costs and import costs in total costs was, respectively, 74 and 26 per cent. This provides an estimate of each of the long-run cost coefficients: 0·74 for wage changes, −0·74 for changes in output per man, and 0·26 for changes in import prices.[1] On this hypothesis the difference between these coefficients and their short-term equivalents in the price equation (7) has then to be allocated over past changes in the explanatory variables. It seems probable that the short-term response is the greatest, so it was assumed that the response of past changes diminished the farther they were removed from the current period.[2] As to the time-span covered by these distributed responses, any assumption must be somewhat arbitrary. By way of

[1] If the coefficient of wage changes is less than unity the change in prices will be less than the change in wages, provided that there is no change in import prices. This would imply a shift in factor shares. But it would also imply a persistent shift in the terms of trade. In fact, though not impossible, this is not normal.

[2] This particular skewed time-form of reaction is quite frequently assumed in the analysis of economic data. See, for example, L. Koyck, op. cit.

illustration, a period of 5 years was taken and the long-term coefficients were distributed as follows:

Explanatory variable:	*Wages and salaries*	*Changes in:*	
		Import prices	*Output per man*
Long-term coefficient	0·74	0·26	−0·74
Distributed as:			
Year (t)*	0·27	0·21	−0·54
Year ($t-1$)	0·20	0·020	−0·08
Year ($t-2$)	0·14	0·015	−0·06
Year ($t-3$)	0·09	0·010	−0·04
Year ($t-4$)	0·04	0·005	−0·02

* For year (t) the coefficients shown are the estimated short-term coefficients of equation (7).

A price relationship completed in this way is necessarily somewhat arbitrary. Nonetheless, it appears to provide a reasonable explanation of factor price changes during the period 1950–9, as shown in Table VII.

TABLE VII

Price Changes, 1950–9: a Long-term Hypothesis
Annual Percentage Changes

Year	*Long-term contribution to price change of:*			*Constant term**	*Calculated price change*	*Actual price change*
	Wage change	*Import price change*	*Productivity change*			
1951	5·7	7·3	−1·2	−0·6	11·2	12·4
1952	5·7	2·1	−0·1	−0·6	7·1	5·9
1953	4·8	−1·6	−1·9	−0·6	0·7	0·2
1954	4·4	−0·4	−1·7	−0·6	1·7	1·7
1955	5·1	0·7	−1·9	−0·6	3·3	3·2
1956	5·5	0·3	−0·5	−0·6	4·7	4·9
1957	5·0	0·7	−1·2	−0·6	3·9	3·8
1958	4·4	−1·6	−0·9	−0·6	1·3	2·5
1959	3·6	−0·5	−2·1	−0·6	0·4	0·3

* This constant has been calculated slightly artificially so that the differences between calculated and actual price changes should sum to zero over the period. It thus results from the fact that the hypothesis as stated is not exactly true: the share of import costs was slightly higher than assumed, and the share of profits fell slightly.

If prices go up as much as costs, this alone is enough to produce constant factor shares in the long run,[1] even without a similar assumption regarding the behaviour of wages. But similar assumptions could also be made about the wage equation. It could be assumed that in the long run

[1] Provided there is no persistent shift in the terms of trade.

there is full price compensation, so that every current wage change would be expected to be as large as some combination of previous price changes, all other things being equal. An experiment was made assuming the following responses:

Long-term coefficient of price change	1·00
Distributed over past price changes as follows:	
Year (t)	0·30*
Year ($t-1$)	0·16*
Year ($t-2$)	0·18
Year ($t-3$)	0·18
Year ($t-4$)	0·18

* As estimated in equation (6).

The results obtained from this form of equation are given in Table VIII. In general the reproduction of actual percentage changes in average wages and salaries is not very successful—certainly not as successful as the earlier price relationship (Table VII). As might be expected, the long-term wage relationship still contains a constant term, equivalent to an annual percentage increase of 1·9 in average wages and salaries: this rate

TABLE VIII

Wages and Salary Changes, 1950–9: a Long-term Hypothesis
Annual Percentage Changes

Year	*Contribution to long-term wage and salary change of:*			*Calculated wage and salary change*	*Actual wage and salary change*
	*Price change**	*Level of demand*	*Constant term†*		
1951	6·6	1·8	1·9	10·3	9·7
1952	5·7	−0·3	1·9	7·3	7·9
1953	4·2	−0·3	1·9	5·8	4·4
1954	4·3	0·5	1·9	6·7	4·9
1955	4·4	1·8	1·9	8·1	8·0
1956	3·2	1·7	1·9	6·8	8·3
1957	2·7	0·2	1·9	4·8	5·6
1958	3·0	−1·2	1·9	3·7	4·0
1959	2·6	−2·2	1·9	2·3	2·9

* The sum of present and past price changes multiplied by the coefficients, adding to unity, set out above.

† Obtained so that the sum of residuals, actual wage and salary change less calculated wage and salary change, should sum as near to zero as possible.

of increase is not far removed from the average increase in output per man (1·7 per cent.) during the years 1950–9. The case for a long-term price coefficient of unity in the wage relationship, however, remains doubtful: the attempt, illustrated in Table VIII, does not provide strong evidence for it.

illustration, a period of 5 years was taken and the long-term coefficients were distributed as follows:

Explanatory variable:	*Wages and salaries*	*Changes in:*	
		Import prices	*Output per man*
Long-term coefficient .	0·74	0·26	−0·74
Distributed as:			
Year (t)* . . .	0·27	0·21	−0·54
Year ($t-1$) . .	0·20	0·020	−0·08
Year ($t-2$) . .	0·14	0·015	−0·06
Year ($t-3$) . .	0·09	0·010	−0·04
Year ($t-4$) . .	0·04	0·005	−0·02

* For year (t) the coefficients shown are the estimated short-term coefficients of equation (7).

A price relationship completed in this way is necessarily somewhat arbitrary. Nonetheless, it appears to provide a reasonable explanation of factor price changes during the period 1950–9, as shown in Table VII.

TABLE VII

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	Wage change	*Import price change*	*Productivity change*			
1951	5·7	7·3	−1·2	−0·6	11·2	12·4
1952	5·7	2·1	−0·1	−0·6	7·1	5·9
1953	4·8	−1·6	−1·9	−0·6	0·7	0·2
1954	4·4	−0·4	−1·7	−0·6	1·7	1·7
1955	5·1	0·7	−1·9	−0·6	3·3	3·2
1956	5·5	0·3	−0·5	−0·6	4·7	4·9
1957	5·0	0·7	−1·2	−0·6	3·9	3·8
1958	4·4	−1·6	−0·9	−0·6	1·3	2·5
1959	3·6	−0·5	−2·1	−0·6	0·4	0·3

* This constant has been calculated slightly artificially so that the differences between calculated and actual price changes should sum to zero over the period. It thus results from the fact that the hypothesis as stated is not exactly true: the share of import costs was slightly higher than assumed, and the share of profits fell slightly.

If prices go up as much as costs, this alone is enough to produce constant factor shares in the long run,[1] even without a similar assumption regarding the behaviour of wages. But similar assumptions could also be made about the wage equation. It could be assumed that in the long run

[1] Provided there is no persistent shift in the terms of trade.

there is full price compensation, so that every current wage change would be expected to be as large as some combination of previous price changes, all other things being equal. An experiment was made assuming the following responses:

Long-term coefficient of price change	1·00
Distributed over past price changes as follows:	
Year (t)	0·30*
Year ($t-1$)	0·16*
Year ($t-2$)	0·18
Year ($t-3$)	0·18
Year ($t-4$)	0·18

* As estimated in equation (6).

The results obtained from this form of equation are given in Table VIII. In general the reproduction of actual percentage changes in average wages and salaries is not very successful—certainly not as successful as the earlier price relationship (Table VII). As might be expected, the long-term wage relationship still contains a constant term, equivalent to an annual percentage increase of 1·9 in average wages and salaries: this rate

TABLE VIII

Wages and Salary Changes, 1950–9: a Long-term Hypothesis
Annual Percentage Changes

Year	*Contribution to long-term wage and salary change of:*			*Calculated wage and salary change*	*Actual wage and salary change*
	*Price change**	*Level of demand*	*Constant term†*		
1951	6·6	1·8	1·9	10·3	9·7
1952	5·7	−0·3	1·9	7·3	7·9
1953	4·2	−0·3	1·9	5·8	4·4
1954	4·3	0·5	1·9	6·7	4·9
1955	4·4	1·8	1·9	8·1	8·0
1956	3·2	1·7	1·9	6·8	8·3
1957	2·7	0·2	1·9	4·8	5·6
1958	3·0	−1·2	1·9	3·7	4·0
1959	2·6	−2·2	1·9	2·3	2·9

* The sum of present and past price changes multiplied by the coefficients, adding to unity, set out above.

† Obtained so that the sum of residuals, actual wage and salary change less calculated wage and salary change, should sum as near to zero as possible.

of increase is not far removed from the average increase in output per man (1·7 per cent.) during the years 1950–9. The case for a long-term price coefficient of unity in the wage relationship, however, remains doubtful: the attempt, illustrated in Table VIII, does not provide strong evidence for it.

These experimental calculations with the constant terms in both short-term equations suggest that there is no constant term in the price equation at least; instead current price changes appear to be the result of a series of changes in costs extending over a fairly long period. In fact a number of prices are infrequently changed. These changes, when made, may relate to historical and not current cost changes. Since many goods take a long path to the final consumer, through several industrial processes, it would follow that changes in final prices were determined by some distribution of past changes in costs extending over several years. Moreover, the short-term changes in profit margins have been small, smaller possibly than would be generally accounted for by the price equation including a constant. The constant term in the wage equation, is less easily explained by the inclusion of past changes in prices, so there remains some doubt as to the form the wage equation should take. This suggests two possible cost/price models; a first, in which neither equation contains a constant; and a second, in which the price equation does not contain a constant but the wage equation does.

The first kind of model implies in the long run full price compensation in wage changes, the long-term coefficient of prices being unity, and full cost compensation in prices. But the combined system is an extraordinarily repetitive one, which, once set in motion by a wage or price change does not damp down very easily. This makes such a model somewhat difficult to believe, although the results given above do not mean it must be rejected. It is, therefore, not impossible that the second model may provide a more plausible description of post-war wage and price changes. In this model there is still a very close link between wage and price changes, but the whole system is subject to the influence of some inflationary element, represented by the presence of the constant term in the wage equation, causing an upward trend in wages and prices. Although the complete system is somewhat repetitive it will tend to damp down about this rising trend, since the price coefficient in the wage equation is not unity but smaller.

6. Conclusions

Some conclusions can be drawn less tentatively than others from the results obtained. The impact of the exogenous variables on the complete wage/price system can be assessed fairly well. The level of demand plays an important part, and the results suggest that the first effect of a 1 per cent. change in the level of demand—roughly equivalent to a similar change in the percentage level of unemployment—gives rise to an annual rate of change of 3 per cent. in average wages and salaries. Similarly, a change of 1 per cent. in import prices appears to have a fairly quick initial effect on

prices, raising them by ¼ per cent. The effect of demand has been estimated from a period during which there has generally been excess demand for labour. It is not at all certain that the same result would hold in a reverse situation of prolonged unemployment.

It is much more difficult to estimate the internal links and the lagged responses in the cost/price system. It seems fairly probable that some delayed responses exist, although it is difficult to verify their time-span. On this point it is quite possible that estimates of short-term reactions tell much less than the whole truth. It is quite possible that the generation of current changes in wages and prices is a longer than annual process, and it might indeed be very lengthy. This would mean that such changes reflect the effects not only of current economic measures, but also of measures taken earlier. The extent to which the effects of earlier measures will be inherited in the current situation finally rests on the internal links. The link between costs and prices, and that between prices and wages, could each, in the long-term, be very rigid. On the other hand, however, the likelihood of some 'semi-political' or non-economic factor operating in the cost/price system cannot be entirely discounted. A factor of this kind could be attributed to some institutional attitude exerting an upward pressure on costs, but this attitude may itself be determined by a long period of high demand, such as that obtaining in the post-war years.

This attempt to analyse wage changes and price changes simultaneously has made it possible to consider more closely the way in which they interact. Such an approach has illustrated the possible inadequacy of the short-term statistical relationships, which do not provide a complete picture of the cost/price mechanism. The internal links still need much further investigation, and it is possible that they could be improved upon by analysing a more complex cost/price system involving more than two equations. Also the rapidity and form of response of wages and prices to their determinants still requires more research. But these uncertainties do not detract from the assessment of the effect of the exogenous variables. Both the pressure of demand, and changes in import prices, are shown to have large immediate effects, even though their later repercussions still remain uncertain.

APPENDIX A

Sources and Methods

THE main series used in the earlier analysis are set out in Table I. A brief description of their derivation and sources follows.

Average wages and salaries were derived from figures for the wage and salary bill published by the Central Statistical Office and the numbers of employees given by the Ministry of Labour.

The aggregate wage and salary bill for the United Kingdom included income from

TABLE I

Average Wages and Salaries, Final Prices, Import Prices, Output per Man, and Excess Demand for Labour, 1946–59

(i) *Index numbers, 1946 = 100* (except demand for labour)

Year	Average wages and salaries per employee	Final prices (of factor sales)	Import prices			Output (G.D.P.) per man	Index of excess demand for labour lagged 1 quarter
			Unlagged	Lagged 1 quarter	Lagged 2 quarters		
1946	100	100	100	100	100	100	..
1947	108·9	106·6	120·3	118·0	112·7	102·3	0·88
1948	119·1	113·2	139·2	138·2	135·3	108·0	0·87
1949	126·4	116·7	141·6	144·6	147·1	112·6	0·45
1950	131·3	119·9	161·2	157·6	152·5	116·0	0·28
1951	144·1	134·8	215·1	209·0	195·4	116·9	0·66
1952	155·5	142·8	210·3	221·4	228·0	116·0	−0·09
1953	162·4	143·1	188·2	196·0	202·7	119·6	−0·12
1954	170·4	145·6	186·6	190·1	191·5	122·7	0·19
1955	184·0	150·2	192·9	196·6	197·9	126·1	0·65
1956	199·3	157·6	196·6	200·0	201·4	126·1	0·60
1957	210·4	163·6	199·8	207·1	207·9	128·2	0·07
1958	218·7	167·7	184·1	190·4	195·8	129·7	−0·43
1959	225·0	168·1	183·0	187·0	189·0	134·4	−0·78

(ii) *Annual percentage changes* (except demand for labour)

1946/7	8·9	6·6	20·3	18·0	12·7	2·3	..
1947/8	9·4	6·2	15·7	17·1	20·1	5·6	..
1948/9	6·1	3·1	1·7	4·6	8·7	4·3	..
1949/50	3·9	2·7	13·8	9·0	3·7	3·0	..
1950/1	9·7	12·4	33·4	32·6	28·1	0·8	..
1951/2	7·9	5·9	−2·2	5·9	16·7	−0·8	..
1952/3	4·4	0·2	−10·5	−11·5	−11·1	3·1	..
1953/4	4·9	1·7	−0·9	−3·0	−5·5	2·6	..
1954/5	8·0	3·2	3·4	3·4	3·3	2·8	..
1955/6	8·3	4·9	1·9	1·7	1·8	0·0	..
1956/7	5·6	3·8	1·6	3·6	3·2	1·7	..
1957/8	3·9	2·5	−7·9	−8·1	−5·8	1·2	..
1958/9	2·9	0·2	−0·6	−1·8	−3·5	3·6	..

employment before taxation paid as wages, salaries, and pay in cash and kind of the Forces. For the period 1946–8 figures were taken from *National Income and Expenditure*, 1946–53, H.M.S.O., table 2 (items 12*a*, 12*b*, and 12*c*). These were linked to data for the period 1948–58 from *National Income and Expenditure*, 1959, table 2 (items 13*a*, 13*b*, and 13*c*). For the year 1959 figures were obtained from *Preliminary Estimates of National Income and Expenditure, 1954 to 1959*, Cmnd. 988.

The employment figures, used to obtain average wages and salaries per employee, relate to the United Kingdom and include persons serving in the Forces. They were all taken from the appropriate issues of the *Ministry of Labour Gazette*. Civilian employees in employment in the United Kingdom were derived from the numbers of employees insured under the unemployment insurance schemes, less the numbers unemployed at the date of the count. Thus from 1946 to 1948 the figure adopted refers to the end of June in each year and for all other years to the end of May in each year. To each of these figures was added the numbers serving in the Forces at the relevant date. Before June 1948 the coverage of the employment figures was not complete. They were, therefore, linked to the post-1948 series, derived from the more complete

count of national insurance cards. As this link can only be roughly made, the figures for average wages and salaries for 1946–8 are less reliable than for later years.

Final factor prices were derived from the same sources given for the aggregate wage and salary bill. For the years 1946–8 average values of final expenditure at factor cost with 1948 = 100, were obtained from the *Blue Book*, 1946–53 (tables 10 and 11). These were linked to average values of final expenditure at factor cost, with 1954 = 100, calculated from the *Blue Book*, 1959 (tables 11 and 13) and Cmnd. 988.

Quarterly interpolations of final prices before 1955 were roughly estimated from the movement of average values of consumers' expenditure, export price indices, and trend estimates of prices of investment goods. For 1955 and subsequent years series were obtained from various issues of *Economic Trends*, H.M.S.O.

Import prices were obtained by linking the different post-war index numbers of total import prices, which have been calculated by the Board of Trade. All series were taken from the *Monthly Digest of Statistics* and no adjustments were made for the changes in weighting introduced from time to time.

Output per man was obtained from estimates of real output divided by the numbers of employees used to calculate average wages and salaries. From 1946 to 1948 index numbers of gross domestic product at 1948 factor cost were taken from the *Blue Book*, 1946–53 (table 12). These were linked to index numbers of output at 1954 factor cost for the years 1948–58 given in the *Blue Book*, 1959 (table 14). For the year 1959 the estimate made by the London and Cambridge Economic Service was used.

The Index of Excess Demand for Labour is discussed in detail in 'Excess Demand for Labour', by J. C. R. Dow and L. A. Dicks-Mireaux, *Oxford Economic Papers*, vol. x, 1958, pp. 1–33. Quarterly series from 1946 to 1956 are given in this article; for subsequent years the figures were taken from the *National Institute Economic Review*, Appendix, table 3. The index moves very closely with the difference between the percentage levels of unfilled vacancies and unemployment.

APPENDIX B

The Method of Two-Stage Least Squares

ALTHOUGH this method has been developed more generally elsewhere,[1] its simple application to a two-equation system is described here.

Let the two structural equations of the system be:

$$y_1 = ay_2 + bx_1 + u \tag{1}$$

$$y_2 = cy_1 + dx_2 + v \tag{2}$$

The y's are the endogeneous variables, the x's the exogeneous or predetermined variables, and u and v are error terms. There is obviously feedback in the system since y_2 is a determinant of y_1 and y_1 a determinant of y_2.

The single-equation least squares method requires that the determinant variables in the equation should be uncorrelated with the error term. This is not so if the least squares method is applied to equation (1), for y_2 is correlated with y_1, by definition in equation (2), and y_1 is correlated with u, by definition in equation (1). It follows that y_2 and u are correlated, and similarly it follows that y_1 and v are correlated. This being so, the single-equation least squares estimates of the coefficients will be biased. Moreover, the extent of the bias in the coefficients of equation (1) will vary with the degree of correlation between y_2 and u, and in equation (2) it will vary with the degree of correlation between y_1 and v.

The two-stage least squares method attempts to overcome this danger of bias by

[1] *Economic Forecasts and Policy*, by H. Theil, North-Holland Publishing Company, Amsterdam, 1958, pp. 334–61.

first considering the reduced forms of the structural equations (1) and (2). The two reduced forms are:

$$y_1 = mx_1+nx_2+w \tag{3}$$

$$y_2 = px_1+qx_2+z, \tag{4}$$

where $m = \frac{b}{1-ac}$, $n = \frac{ad}{1-ac}$, $w = \frac{u+av}{1-ac}$,

and $p = \frac{bc}{1-ac}$, $q = \frac{d}{1-ac}$, $z = \frac{cu+v}{1-ac}$.

These two reduced forms may now be estimated singly by the method of least squares since there no longer exists the danger that the independent variables (x_1 and x_2, now) will be correlated with the error terms (w and z). Thus calculated values of y_1 and y_2 may be obtained from the estimated equations:

$$\hat{y}_1 = \hat{m}x_1+\hat{n}x_2 \tag{5}$$

$$\hat{y}_2 = \hat{p}x_1+\hat{q}x_2. \tag{6}$$

The estimates of the true values of the coefficients m, n, p, and q in equations (5) and (6) provide, therefore, estimates of y_1 and y_2 which will tend to be uncorrelated with the error terms u and v in equations (1) and (2) as the sample increases. Therefore, substituting the calculated values of y_1 and y_2 in the original equations, each of these equations may be estimated singly by the method of least squares, and the risk of obtaining biased estimates of the coefficients is considerably reduced.

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TOWARDS A THEORY OF DIVERSIFICATION

By MALCOLM R. FISHER

I

TRADITIONAL theories of the firm have come in for considerable criticism in recent years. Much of the debate, however, has turned on the undue narrowness of the assumption of profit maximization rather than on the ability of existing deductive theories to explain the empirical behaviour of firms. Yet the contribution of existing theory nowhere appears more limited than in the explanation of the *modus vivendi* of the ubiquitous multi-product firm, the characteristic, not the atypical, unit of enterprise. For illumination we must go to the treatises on industrial structure, formal theory having become excessively preoccupied with the single-product firm.

This article makes some attempt to redress the balance. By limiting our inquiry to the impact of uncertainty in competitive situations where firms are subject to financial restraints we shall endeavour to bring out in bold relief instances where diversification (or the lack of it) constitutes sensible entrepreneurial policy.[1]

It is perhaps useful at this juncture to draw up a simple classification of the circumstances in which a firm may be induced to produce more than one product.

We may first distinguish between the economic and the non-economic. The latter comprise:

(*a*) Rigid proportions as a direct consequence of known techniques of production.

(*b*) Variable proportions within given methods of production. Wheat and straw or mutton and wool are familiar examples.[2]

(*c*) Diversification resulting from technical advantages as, for example, crop rotation and the interleaving of crops. It is noteworthy that improvements in soil fertility associated with crop rotation state a case for rotation through time, not for the growing of a variety of crops at any one time. Space saving and resistance to insect pest or disease may be more important here.

[1] I am grateful to Mr. M. J. Farrell for his comments on a first draft.

[2] Even here, of course, the economic principle of substitution is relevant. Marshall makes a number of interesting points, but his entire analysis seems pertinent to a situation where products are already being produced together, not to one where a decision must be made as to whether production might with advantage take place in highly specialist firms throughout. See *Principles*, book v, chap. vi, 8th edn., London, 1920; *Industry and Trade*, London, 1919, pp. 193–4. These comments would seem to apply to the treatment by Prof. J. R. Hicks and J. Mosak: also J. R. Hicks, *Value and Capital*, 2nd edn., Oxford, 1946; J. Mosak, *General Equilibrium Theory in International Trade*, Principia Press, 1944.

The economic case for product-mix may be conveniently grouped under three headings:

(*a*) **Imperfections of competition.** Under profit maximization the optimum solution is for the firm to choose the amount to be produced of each product by the rule that the ratios of marginal revenues of each pair of different products equal the ratios of their marginal costs. Generally monopolistic competition or oligopoly is implied. In the former sphere opinion now veers to the view that demand curves do not diverge much from the horizontal;[1] in the latter what appears as a kinked demand curve in the short run turns out to be virtually perfectly elastic in the long.[2] These raise doubts as to whether the demand side of the analysis can bear all the weight imposed on it.[3]

The imperfections may alternatively be the familiar features of monopoly power, forward or backward integration, or the benefits of exclusive dealer arrangements with full line productions.

(*b*) **Uncertainty.** Entrepreneurs plan and execute production with considerable uncertainty as to reward. Incorrect decisions prove costly, even spelling death of a firm. A profit more certain of attainment may be more or less attractive than the small chance of a much larger profit. The cautious follow the maxim 'Don't put all your eggs in one basket'; the speculative are men who pin their faith on the result of a single throw of the die.

The buttresses against uncertainty take many forms. Producers of commodities in cyclical demand often produce other lines in more stable demand.

[1] R. F. Harrod, *Economic Essays*, London, 1952, Essay 8.

[2] W. J. Fellner, *Competition among the Few*, chap. v, New York, 1949; M. J. Farrell, 'An Application of Activity Analysis to the Theory of the Firm', *Econometrica*, vol. xxii, No. 3, July 1954, pp. 291–302.

[3] E. W. Clemens, 'Price Discrimination and the Multiple Product Firm', *Review of Economic Studies*, vol. xix (1950–1), pp. 1–11. Drawing upon the monopolistic competition theories of the thirties E. W. Clemens has explained product-mix in terms of price discrimination theory. There is a declining demand curve for each product and the entrepreneur, faced with a rising marginal cost curve which is independent of the product-mix, carries production of each line to the point where marginal revenue on each product is the same.

The optimum rule then is that these marginal revenues must equal the marginal cost of the aggregate output. Clemens rides roughshod over the index number problem. If it is impossible for the supply curves of competitive firms producing dissimilar products to be aggregated, it is likewise impossible to add together the demands for different products to form one aggregate demand curve. Without the benefit of this procedure much of the analogy with the theory of price discrimination is lost. In any event the assumption that the marginal cost is independent of the product-mix makes the theory very crude on the supply side.

But even if we accept this analysis as a first approximation we are confronted with the empirical difficulty that some of the more monopolistic firms tend to be more or less one-product firms, e.g. British Oxygen, Showerings. Moreover this theory, which is meant to provide an explanation of multi-product production as opposed to joint production contains the derivative implication that under conditions of perfect elasticity of demand (technical considerations apart) there is nothing to be gained by producing more than one product. There do not seem to be adequate *a priori* grounds for accepting this conclusion.

Product-mix may be the result of uncertainty in factor markets. Violent swings in the prices of raw materials may lead to the selection of factors whose prices are negatively correlated. Confectionery is an example where dissimilar movements in sugar and cocoa prices may make it advantageous for firms to produce chocolate and candies.[1]

Or again, firms producing products in seasonal demand tend to develop a main line for the off-season too as the common production of sausages and ice cream bears witness.[2]

(*c*) **Dynamic aspects.** Demand which is stable over reasonable periods of time gradually becomes saturated or eliminated by the rise of new wants. Entrepreneurs are always on the lookout for new products which will prove money-makers in the future. This may lead to simultaneous production of an array of products which reach their peak demands at different stages through time.

Research activity within a firm will suggest new products and techniques, but whether innovation results will depend on their profit potential and the phase of the life-span of the products already in course of production as well as upon the risk-attitude of the entrepreneur.

Our study is concerned with multi-product production, not marketing, and would seem to exclude the case where firms sell a wide range of goods because of the convenience yield manifest in lower searching costs to the buyer. The buyer may, of course, think that the benefits from a known quality carry over to other products from those in which the entrepreneur has made his name. But this is more likely to strengthen the argument for product-mix based on other criteria than to provide a case on its own merits.[3]

[1] *The Times*, 26 May 1958, p. 11.

[2] Writers on economic structure come nearer to an adequate treatment of the problem. For example, E. A. G. Robinson in *Structure of Competitive Industry*, Nisbet, 1st edn., p. 116, states: 'We see it [the multi-product firm] distributing its activities as best it can between products whose markets are declining and those whose markets are growing, between highly profitable but seasonal or intermittent markets and steady-selling but low-profit markets, expanding when times are good or exceptional opportunity offers, disposing of subsidiaries or closing down on certain activities when times are bad.'

And again: 'In making its decisions the firm may, if it is brave, back its judgment that if it concentrates all its resources on making some new product or some old product greatly improved, it can keep its capital profitably employed and its employees fully at work. But in many cases a firm, either from cowardice or prudence, will prefer to spread its risks. It will introduce new products while going ahead with old products. It will try tentatively to see whether it can make a success of some new line of business while clinging also to the things in which it knows that it has experience. Thus out of uncertainty grows the multi-product firm, dividing its energies and resources between a variety of types of output.'

[3] W. B. Reddaway, 'The Chemical Industry', *The Structure of British Industry*, chap. vi, edited by D. Burn, Cambridge, 1958.

The advantages arising from exclusive-dealer arrangements we have already referred to. See J. Duesenberry, *Business Cycles and Economic Growth*, 1958, p. 82.

Duesenberry lists a further argument—economies of scale in the use of salesmen, trucks, and warehouses and possibly in accounting and advertising. It is not clear that these establish a case for product-mix as opposed to greater amounts of a single product. Shell and B.P. share distribution outlets. The possibility of spreading these economies across products

Certain qualifications to the adequacy of a theory of product-mix premised upon (*a*) have been advanced. This paper is an attempt to provide a simple theory premised upon (*b*) which will also serve as an introduction to an analysis of (*c*).

II

Using highly specific assumptions we now proceed to apply our theory of decision-making under uncertainty to the firm. For this purpose we assume that the firm operates under competitive conditions, prices of factors and products being determined independently of its actions. These prices need not be known for certain. We merely assume that the entrepreneur is able to envisage characteristics of the joint distribution function of prices and that knowledge of the means, variances, and covariances of prices proves sufficient for the formulation of his plans.

Entrepreneurial motivation should be governed by a simple maximizing rule, but clearly one must be more specific than in the certainty case. Several alternatives suggest themselves: maximization of the mathematical expectation of profits, minimization of the chance of profit being less than a certain amount or maximization of utility defined as a function of the mean, and variance of profits. We follow Lange, Lutz, Modigliani, and Tobin[1] and plump for the last.

Within this implicit function two categories of behaviour may be represented.

1. That where both mean and variance of profits yield positive utility to the firm.
2. That where mean profits yield utility but the variance renders disutility.

Tobin[2] has attempted to provide some deeper rationalization for the employment of this type of utility function. He finds that this class of utility function can be a correct representation either (i) where the entrepreneur is presumed to maximize a utility of profit function where prices, and hence profits, are subject to a probability distribution that belongs to a two-parameter family such as the normal distribution law, or (ii) where the entrepreneur is deemed to act as though the utility of profit function is quadratic.

serves to confirm the case of product-mix on other grounds rather than helping to provide any additional arguments of substance. It merely tends to show that economies of scale are not entirely dependent upon concentration on one product.

[1] O. Lange, *Price Flexibility and Employment*, Principia Press, 1952, chap. vi; F. A. and V. Lutz, *Theory of Investment of the Firm*, Princeton, 1951, chap. xv; F. Modigliani and M. Zeman, 'The Effect of the Availability of Funds, and the Terms thereof, on Business Investment', *N.B.E.R. Conference on Research in Business Finance*, 1952, pp. 263–97; J. Tobin, 'Liquidity Preference as Behaviour towards Risk', *Review of Economic Studies*, vol. xxv (2), no. 67, Feb. 1958, pp. 65–86.

[2] Tobin, op. cit., pp. 74–76.

But whichever of these representations is chosen there are restrictions. The utility function must be concave to the variance axis in (1) and concave to the mean profits axis in (2). Convexity is excluded. However, we cannot be sure that these two representations exhaust the possibilities. We cannot argue from the particular to the general and rule out convexity entirely. Tobin himself assumes the possibility of convexity in (2) and we should not wish to eliminate it from case (1) either.[1]

We make the customary assumption that the technical constraints upon the entrepreneur are independent of his utility function but depart from tradition in assuming that these take the form of limits on finance,[2] not of fixed input or entrepreneurial ability. The finance available is treated as known. Again, as a general rule, the production function is treated as dependent solely on technical conditions of production and therefore data to the economist. We prefer to regard the optimum range of products and factors as something to be determined on economic criteria. To this end we assume that each product has its own production function, neglecting, in the present discussion, the possibility that cost economies may be achieved through product-mix.[3] We neglect also the constraints that may arise through growth in the variety of goods produced, regarding these as ineffective in practice because of the prior constraint on finance.

We denote product i by x_i and the inputs employed in its manufacture u_1, u_2, u_3, &c.:

$$x_i = f(u_1, u_2, u_3, \ldots).$$

As we wish to draw a sharp distinction between production under increasing and under decreasing returns to scale our production functions must be more explicit. We assume that to produce x_i we require a single measurable input u_i and that the production function is of the form

$$x_i = u_i^a.$$

If $a < 1$, a constant multiple times input yields less than that multiple of output; conversely if $a > 1$. To focus attention upon the product as opposed to the input mix we shall assume that factor prices are known with certainty and that entrepreneurs desire to use their available financial resources to the full. This presumes that profit expectations are such as to justify the use of all available finance and permit an adequate return assessed in terms of opportunity cost.

Let M denote the total finance available and the entrepreneur have in prospect the possible manufacture, either singly or in combination, of two

[1] Tobin, op. cit., p. 77.

[2] See, however, J. de V. Graaff, 'Income Effects and the Theory of the Firm', *Review of Economic Studies*, 1950–1, pp. 79–86.

[3] We choose to neglect entirely problems of interdependence on the cost side. These are well treated by J. C. Weldon, 'The Multi-product Firm', *Canadian Journal of Economics and Political Science*, vol. xiv (1948), pp. 176–90.

products, x_1, x_2, each of which requires the services of one input, in the former u_1, in the latter u_2.

The production possibility loci may be written

$$x_1 = u_1^a, \qquad x_2 = u_2^b,$$

where a and b are greater than zero.

Let $M = u_1 q_1 + u_2 q_2$ be the finance constraint, where q_1, q_2 are prices of inputs u_1, u_2 respectively.

Given that the entrepreneur uses his financial resources to the full, he can produce all x_1, or x_2, or a combination. The relationship in u_1 and u_2 which prescribes the possible product combinations available is

$$x_1^{1/a} q_1 + x_2^{1/b} q_2 = M.$$

This function is downward sloping in the x_1, x_2 axis. Moreover, it is concave to the origin if both a and b are less than 1 and convex if both a and b are greater than 1. That is to say, when decreasing returns to scale apply to both products, the production frontier is concave to the origin, when increasing returns to scale prevail, convex to the origin. In other cases the rate of change in the shape of the curve depends on the relative magnitude of

$$a, \ b, \ q_1, \text{ and } q_2.$$

We denote the mean price of product x_1 by $\bar{P}_1$, its variance by σ_1^2, that of x_2 by $\bar{P}_2$ and σ_2^2 respectively, and the covariance of the product prices by $\sigma_{12} = \Gamma_{12} \sigma_1 \sigma_2$, where Γ_{12} is the correlation coefficient.

We wish to maximize the utility function as defined. In a situation where factor prices are known with certainty and every unit of available finance is absorbed, the maximization of a utility function in which the mean and variance of revenue are substituted for those of profits will select the same proportionate combination of product. This function will only differ from its predecessor by a movement of origin a distance M along the mean profits axis.

In the x_1, x_2 plane the production frontiers for $a, b > 1$ are depicted in Fig. 1*a*; for $a, b < 1$ in Fig. 1*b*. The mean price-ratio curve for x_1, x_2, a straight line of negative slope, $\bar{R} = x_1 \bar{P}_1 + x_2 \bar{P}_2$ denotes all combinations of x_1, x_2 of equal mean revenue. With given factor cost it is a vertical displacement of the curve denoting combinations of x_1, x_2 of equal expected mean profit.

A more difficult specification is that of the variance of profits, which under constant cost, equal the variance of revenue.

The variance of profits is defined thus:

$$\sigma_P^2 = \sigma_R^2 = x_1^2 \sigma_1 + x_2^2 \sigma_2^2 + 2 x_1 x_2 \Gamma_{12} \sigma_1 \sigma_2,$$

where Γ_{12} denotes the coefficient of correlation between P_1 and P_2.

This equation is that of a conic in x_1, x_2 of form $Ax_1^2+Bx_2^2+2Cx_1x_2$. Since $|\Gamma_{12}| \leqslant 1$, $AB \geqslant C^2$. When $AB > C^2$ the equation is that of an ellipse and as the dispersion of profits varies a set of concentric ellipses is traced out.

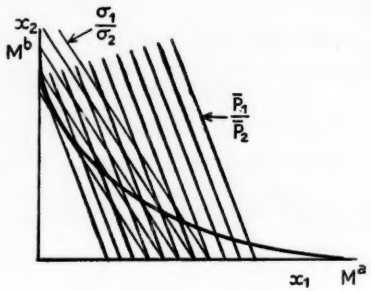


FIG. 1 *a*

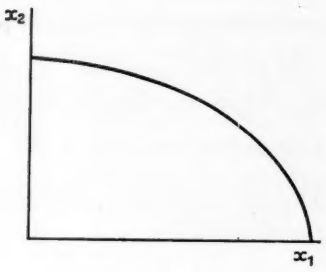


FIG. 1 *b*

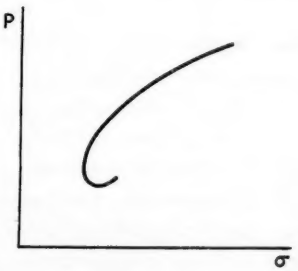


FIG. 1 *c*

When $AB = C^2$, $\Gamma_{12} = \pm 1$ and the variance of profits function degenerates into a pair of straight lines.

The only portion of the graph of these functions that is relevant is that which falls in the top right-hand quadrant since, by assumption, $x_1, x_2 \geqslant 0$. We shall first investigate the straightforward cases where $|\Gamma_{12}| = 1$; then consider $\Gamma_{12} = 0$ before treating the more general case where $0 < |\Gamma_{12}| < 1$.

Group A. $\Gamma_{12} = +1$

Even this restriction leaves a number of possible combinations for examination. The product with the greater mean price may have the smaller or the larger variance. The production frontier may be concave or convex or mixed (the last we leave to the interested reader). The position of the production frontier depends upon the relative magnitudes of the given factor prices q_1, q_2 as well as on a and b. For simplicity we shall restrict our study to those cases where input prices are equal: $q_1 = q_2 = 1$.

I. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $a > b > 1$

The variance of profits (revenues) takes the degenerate form of a pair of straight lines

$$(x_1\sigma_1 + x_2\sigma_2)^2 = \sigma_P^2 = \sigma_R^2.$$

Since x_1, x_2, σ_1, σ_2 are positive the relevant line is $x_1\sigma_1 + x_2\sigma_2 = \sigma_P$, which is of negative slope $-\frac{\sigma_1}{\sigma_2}$, in the x_1, x_2 plane. Since $\bar{P}_1 > \bar{P}_2$ and $\sigma_1 > \sigma_2$ both the mean price-ratio line $x_1\bar{P}_1 + x_2\bar{P}_2 = \bar{R}$ and the root-variance ratio line (which since there is no ambiguity we shall call the variance-ratio line) have slopes in excess of 45°. We must distinguish cases where $\frac{\bar{P}_1}{\bar{P}_2} \gtrless \frac{\sigma_1}{\sigma_2}$. This distinction may be expressed more neatly in terms of coefficients of variations (V):

$$V_1 < V_2 \quad \text{implies} \quad \frac{\bar{P}_1}{\bar{P}_2} > \frac{\sigma_1}{\sigma_2},$$

$$V_2 < V_1 \quad \text{,,} \quad \frac{\bar{P}_1}{\bar{P}_2} < \frac{\sigma_1}{\sigma_2}.$$

The production frontier, depicted by the curve M^bM^a in Fig. 1 *a*, is convex to the origin. On the same graph we draw the mean-price and variance-ratio lines. Every point on the production frontier lies on a price-ratio line and a variance-ratio line. Where these particular ratio lines intersect the x_1-axis we may read off the values of mean revenue and variance as distances from the origin. From these values for every point on the production frontier we may construct the $(\bar{R}, \sigma_R)$ curve.

Fig. 1 *c* gives one possible shape of this curve when $V_1 < V_2$. This takes the form of a hook open to the right.

In Fig. 1 *a* we observe that an entrepreneur wishing to maximize mean profits will produce x_1 alone; one wishing to maximize profit variance will do the same. Hence an entrepreneur wishing to maximize a utility function in which both mean and variance of profits are accorded positive weights will choose to produce x_1 alone.

Despite this simplification we shall consider all four distinct patterns of behaviour that the utility function in profits (P) $u(\bar{P}, \sigma_P)$ may typify.

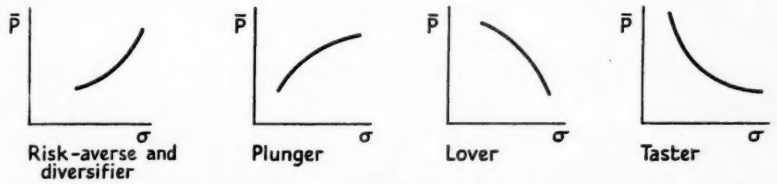
The first of these is one where mean profit has positive utility, variance negative utility, and where, for combinations between which the entrepreneur is indifferent, for every unit gain in mean profits the associated addition to profit variance will become smaller, the higher mean profits already are. This case has been christened 'risk-aversion' (diversifier).[1] Risk-aversion may also occur when the indifference curves are linear or concave to the variance axis. Tobin calls this 'the case of the plunger'.

[1] Tobin, op. cit., pp. 73–74.

After every successive addition to variance less and less extra mean profit is necessary to remain on the same level of utility.

The third case is one where both the mean and variance of profits provide positive utility, but with each successive addition to profit variance more mean profit must be sacrificed to remain on the same indifference curve. This is dubbed 'the case of the risk-lover'.[1] It is possible to conceive of another case—that where after each successive addition to profit variance, mean profits must fall by smaller and smaller amounts if the same utility level is to be preserved. We shall name this type of behaviour that of 'the risk-taster'. Risk-lovers' indifference curves are concave to the origin, risk-tasters convex.

Assuming continuous functions, the general shape of these constant utility curves is unaffected by transformation of variables from profits to revenue since total cost is held constant. The shape of all four is shown below.



We must next ascertain the admissible shapes of the $\bar{P}$, $\sigma_P(\bar{R}, \sigma_R)$ possibility loci. It is essential to distinguish cases where either or both ratio lines may be tangential to, from those where they are always intersectors of, the production frontier.

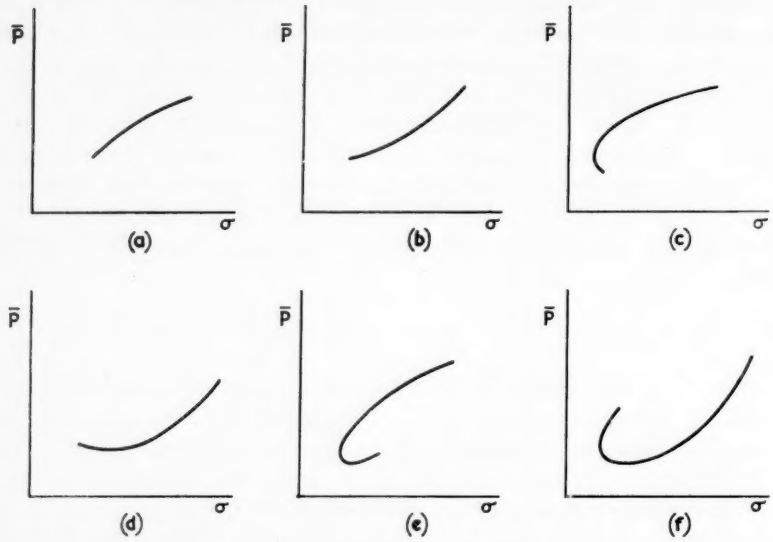
Six cases must be distinguished as is clear from the table and diagrams below.

	Relation between coefficients of variation	*Tangency of ratio lines*	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*
(i)	$V_1 < V_2$	none	*a*	D, HE, LE	D, HE
(ii)	$V_1 > V_2$	none	*b*	D, HE, LE	LE, HE
(iii)	$V_1 < V_2$	variance	*c*	D, HE	D, HE
(iv)	$V_1 > V_2$	price	*d*	D, HE, LE	HE, LE
(v)	$V_1 < V_2$	both	*e*	D, HE	D, HE
(vi)	$V_1 > V_2$	both	*f*	D, HE, LE	HE, LE

We may now superimpose the relevant utility functions. The optimum groupings for the entrepreneur are then given by the points of mutual tangency of the $\bar{P}$, σ_P locus and the indifference curves. From these we can quickly determine whether the optimum implies diversification (D) or

[1] Tobin, loc. cit.

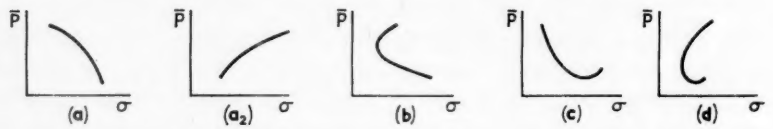
production of the product with the lower (LE) or higher mean price (HE). The results are shown in the last two columns of the above table. Clearly we do not need to list the cases of the risk-lovers and tasters as they will always produce x_1 alone. Risk-averters are, on the other hand, very likely to produce some of each product.



II. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $a > b > 1$

Now that we have worked through one example in detail we shall merely list the results of the others in summary tables and diagrams. For this class $V_1 < V_2$.

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	a or a_2	HE, LE, D	HE, LE, D	HE, LE, D	HE, LE, D
(ii)	variance	b	HE, D	HE, D	LE, HE	LE, HE
(iii)	price	c	HE	HE	HE, LE	HE, LE, D
(v)	both	d	HE, D	HE, D	HE	HE

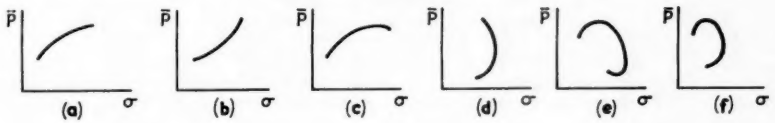


The variation of cases I and II when $b > a > 1$ are left to the reader.

III. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $1 > a > b$

The production frontier is now concave to the origin.

	Relation between coefficients of variation	*Tangency of ratio lines*	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	$V_1 < V_2$	none	*a*	LE, D, HE	LE, D, HE	HE	HE
(ii)	$V_1 > V_2$	none	*b*	LE, D, HE	LE, HE	HE	HE
(iii)	$V_1 > V_2$	price	*c*	D, LE	D, LE	D, HE	D, HE
(iv)	$V_2 > V_1$	variance	*d*	LE, HE	LE, HE	D, HE	D, HE
(v)	$V_1 < V_2$	both	*e*	D, HE	D, HE	D	D
(vi)	$V_1 > V_2$	both	*f*	D, HE, LE	D, HE	D	D

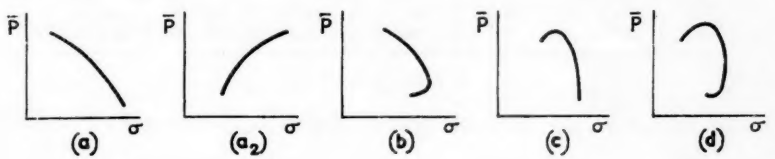


One interesting comparison with the certainty case emerges. Under (iii), (v), and (vi) diversification would inevitably occur under certainty, whereas complete specialization could result under uncertainty.

IV. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $1 > a > b$

$V_1 < V_2$.

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	a or a_2	HE, LE, D	HE, LE, D	HE, LE, D	HE, LE, D
(ii)	variance	*b*	HE, LE	HE, LE	D, HE	D, HE
(iii)	price	*c*	HE, D	HE, D	LE, D	D, LE
(iv)	both	*d*	HE, D	HE, D	D	D



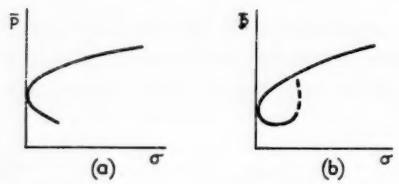
Group B. $\Gamma_{12} = -1$

The variance-ratio lines take on positive slope and can no longer be tangential to the production frontier. To the left of the line $x_1\sigma_1 - x_2\sigma_2 = 0$

their equation is $x_2\sigma_2 - x_1\sigma_1 = \sigma_P$; to the right $x_1\sigma_1 - x_2\sigma_2 = \sigma_P$. Thus variance increases as the parallel lines move farther in either direction from the particular line that passes through the origin. In the summary of cases which follow we need only distinguish between those where the price-ratio line is tangential to the production frontier and those where it is not.

I. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $a > b > 1$

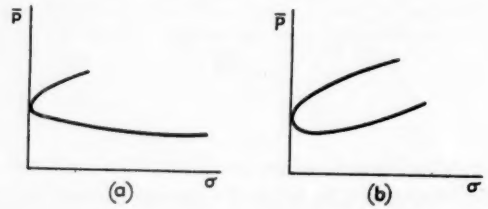
	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*
(i)	none	*a*	HE, D	HE, D
(ii)	price	*b*	HE, D	HE, D



Obviously risk-seekers will produce x_1 alone.

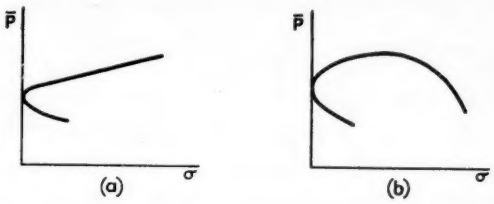
II. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $a > b > 1$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	HE, D	HE, D	HE, LE	HE, LE
(ii)	price	*b*	HE, D	HE, D	HE, LE	HE, LE



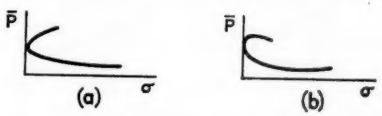
III. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $1 > a > b$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	D, HE	D, HE	HE	HE
(ii)	price	*b*	D	D	D, HE	D, HE



IV. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $1 > a > b$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	D, HE	D, HE	HE, LE	HE, LE
(ii)	price	*b*	D, HE	D, HE	HE, LE, D	HE, LE, D



Group C. $\Gamma_{12} = 0$

The variance constraint now takes the form

$$\sigma_P^2 = x_1^2\sigma_1^2 + x_2\sigma_2^2,$$

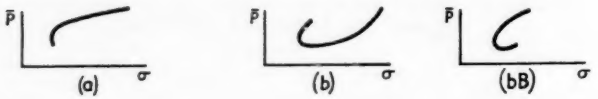
which is the equation of an ellipse through the origin as centre with semi-axes $\frac{\sigma_P}{\sigma_1}$, $\frac{\sigma_P}{\sigma_2}$ respectively. As σ_P^2 increases a set of concentric ellipses is generated. Every point on an ellipse gives equal variance, but only positive or zero values of x_1 and x_2 are acceptable.

We consider four cases.

I. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $a > b > 1$

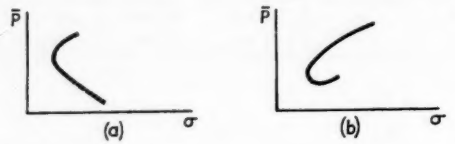
Risk-lovers and tasters will choose to produce x_1 alone.

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*
(i)	none	*a*	D, HE	D, HE
(ii)	price	*b* or *b*B	LE, D, HE	LE, D, HE



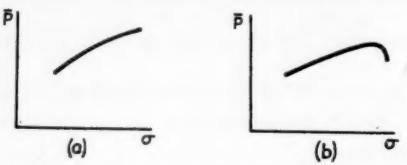
II. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $a > b > 1$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	D, HE	D, HE	LE, HE	LE, HE
(ii)	price	*b*	D, HE	D, HE	LE, HE	LE, HE



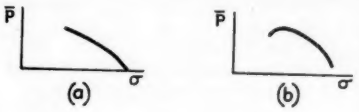
III. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 > \sigma_2$; $1 > a > b$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	LE, D, HE	LE, D, HE	HE	HE
(ii)	price	*b*	LE, D	LE, D	D, HE	D, HE



IV. $\bar{P}_1 > \bar{P}_2$; $\sigma_1 < \sigma_2$; $1 > a > b$

	Tangency of ratio lines	*Diagram showing nature of locus*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
(i)	none	*a*	HE	HE	HE, LE, D	HE, LE, D
(ii)	price	*b*	HE, D	HE, D	HE, LE, D	HE, LE, D



The General Case. $\Gamma_{12} \neq 0$; $-1 < \Gamma_{12} < 1$

It is possible to reduce the equation giving the variance of profits to the standard form applicable when $\Gamma_{12} = 0$ by rotating the axes through an angle θ given by

$$\tan 2\theta = \frac{2r\sigma_1\sigma_2}{\sigma_1^2 - \sigma_2^2}.$$

By the use of the concentric circle method[1] we can readily discover the major axis of this ellipse. As already suggested by case I it is the one sloping from second to fourth quadrants when $\Gamma_{12} > 0$ and from third to first quadrants when $\Gamma_{12} < 0$. The length of the major axis will be the greater, the greater Γ_{12} for given σ_1^2, σ_2^2 and the larger the difference in magnitude between σ_1^2 and σ_2^2 for given Γ_{12}. Moreover, the greater is Γ_{12} the greater is the difference in length between major and minor axes.

When $x_1 = 0$, $x_2 = \frac{\sigma_P}{\sigma_2}$; when $x_2 = 0$, $x_1 = \frac{\sigma_P}{\sigma_1}$. Thus the ellipse passes through the end points of the semi-axes of the ellipse with the same σ_1^2, σ_2^2 but $\Gamma_{12} = 0$. The axes after rotation must lie within the variation in slope of $\pm\frac{\sigma_1}{\sigma_2}$ from the original position since $|\Gamma_{12}| < 1$. For any given value of the profit variance it is clear that when Γ_{12} is negative the ellipse protrudes farther into the first quadrant than when $\Gamma_{12} = 0$ and, *a fortiori*, than when Γ_{12} is positive. It will, however, provide the same value of σ_P at the point of mutual intersection with the production frontier and the original axes irrespective of the value of Γ_{12}.

Before we select a few cases for examination one general point may be made. The ellipse representing the variance will always be tangent to the production frontier at some point other than the extremities of the latter. Thus we need only distinguish examples which differ in the characteristics

[1] D. M. Y. Somerville, *Analytical Conics*, London, 1941, p. 115.

of the production frontier and according as the price-ratio line is or is not tangent to that frontier.

Summary of Examples Chosen

$(-1 < \Gamma_{12} < 0)$

Specification	*Tangency of price-ratio lines*	*Risk-averter*	*Plunger*	*Risk-lover*	*Risk-taster*
I					
$a > b > 1$ $\bar{P}_1 > \bar{P}_2$	(i) No	HE	D, HE	LE, HE	LE, HE
$\sigma_1 > \sigma_2$	(ii) Yes	D, HE	D, HE	LE, HE	LE, HE
II					
$a > b > 1$ $\bar{P}_1 > \bar{P}_2$	(i) No	D, HE	D, HE	LE, HE	LE, HE
$\sigma_1 < \sigma_2$	(ii) Yes	D, HE	D, HE	LE, HE	LE, HE
III					
$1 > a > b$ $\bar{P}_1 > \bar{P}_2$	(i) No	D, HE	D, HE	LE, HE	LE, HE, D
$\sigma_1 > \sigma_2$	(ii) Yes	D	D	LE, HE	LE, HE, D
IV					
$1 > a > b$ $\bar{P}_1 > \bar{P}_2$	(i) No	D, HE	D, HE	LE, HE	LE, HE, D
$\sigma_1 < \sigma_2$	(ii) Yes	D, HE	D	LE, HE	LE, HE, D

The examination of cases where Γ_{12} is positive is left to the interested reader. However, one can say that, other things being equal, the profit variance for every point on the production frontier will be greater when Γ_{12} is positive than when Γ_{12} is negative.[1] Moreover, when $\frac{\bar{P}_1}{\bar{P}_2}$ exceeds a critical value and $\sigma_1 > \sigma_2$ the profit at the point where the production frontier is tangential to the ellipse of minimum profit variance will be smaller when $\Gamma_{12} > 0$ than when $\Gamma_{12} < 0$ and vice versa for $\sigma_1 < \sigma_2$. From these remarks it is clear that risk-averters and plungers will, other things being equal, prefer situations where Γ_{12} is negative to those where $\Gamma_{12} \geqslant 0$ whereas the risk-seekers may under certain circumstances prefer Γ_{12} to be > 0. Risk-lovers will not, as a general rule, exert this preference since their choice will be restricted to the end points of the $\bar{P}$, σ_P curve which are determined independently of the size of Γ_{12}.

[1] Except for points on the axes.

III

Two broad conclusions can legitimately be drawn from our analysis.

(i) Under increasing returns to scale whereas the firm under certainty would tend to specialize completely, the firm under identical conditions of production but uncertain as to the profits it will obtain may prefer to spread its production over two products, or more generally a number of products.

(ii) Under decreasing returns to scale whereas the firm under certainty would tend to produce some of each, the firm under identical conditions of production but uncertain as to the profits it will obtain may prefer to concentrate its production on one product alone. Moreover, this decision in favour of complete specialization may be made by a cautious entrepreneur or by a very aggressive risk-taker.

From the much greater range of possibilities rendered possible once the assumption of certainty is relaxed, the only other more or less general conclusion that may be drawn is that, other things being equal, risk-averse entrepreneurs will prefer to produce combinations of products whose prices are negatively correlated, whereas risk-lovers' selection will be tilted more in favour of products whose prices are positively correlated. Whether this means that in a multi-product situation entrepreneurs who are cautious would choose to produce goods where the simple correlations between the prices of pairs of products were predominantly negative is a question as yet unexplored.

While our study does not yield just a few neat generalizations it does enable us to assess the consequences of a tug of war between the economies of specialization on the one hand, and the attractions of risk-offsetting or entrepreneuring on the other.

We have preferred to limit our analysis to two products and retain the expository convenience of a geometric approach but the underlying mathematics is completely general. For those who find the competitive assumption unrealistic it may be mentioned that the transition to the specification of a demand curve appropriate to monopolistic competition[1] is easily made. But if one judges a theory, not by its assumptions alone, but also by its implications, there are many aspects of economic behaviour that may be illumined by these theorems.

In the broad categories we have examined the choice between diversification and specialization depends ultimately on the nature of the utility function. Let us, for the moment, suppose that all entrepreneurs exhibit

[1] If we assume linear demand curves of the form $P_1 = \alpha_1 x_1 + \gamma t_1$, where t_1 is the average price charged by other firms, we find that the mean profits may be expressed as a quadratic in x_1, x_2 in the case of two products. Geometrically under the conditions assumed this also takes the form of an ellipse whose centre represents the point of maximum mean profits. The analysis in general proceeds as before.

the same class of behaviour pattern. If they are risk-lovers they will most probably choose to specialize completely. If production offers economies of scale, oligopoly or monopoly may eventuate with a complete breakdown in the competitive assumptions. But a large number of firms, each limited in finance, could continue to exist. In fact this case might be said to bear some resemblance to the aggressive competitive environment implied in perfect competition. In our situation the entry of new or the exit of old firms will not only lower or raise the mean prices of products but will alter the variance and even the covariance of prices as well. The impact on the latter is difficult, if not impossible, to assess *a priori*, but it is clear that in an industry made up of risk-lovers the normal rate of profit which is thought satisfactory will be rather smaller, other things being equal, than in risk-averse situations.

The risk-loving entrepreneur may be near to the type envisaged by those who have emphasized the advantages of a keenly competitive[1] situation. Certainly he seems to fit Schumpeter's[2] description rather closely in a number of respects.

Risk-aversion with its inducement to diversification is not a characteristic of the Schumpeterian entrepreneur, but may go some way to answer Mr. Sraffa's[3] question as to how increasing returns and competition can be reconciled. Difficulties of borrowing and the principle of increasing risk retard a firm's rate of expansion and may become operative[4] before a firm is in a position to dominate its market. These brakes may be applied because of the management's own fears or indirectly in a stock market short of risk-seeking investors because there is sufficient pressure from risk-shy investors to thwart aggressive entrepreneurs in their attempts to specialize.

The explicit introduction of time would seem to be the obvious next step in our line of attack. It is upon this aspect that Professor Robinson[5] has laid stress. To make the theory dynamic one must introduce the time distribution of prices over the planning horizon. Though it is dangerous to generalize in such a field, we may anticipate that the mean price of a new product, cost considerations apart, may start high and gradually fall, while the variance of the price, on the other hand, may at first decline,

[1] A. Marshall, *Principles*, books iv and v; F. Knight, *Risk, Uncertainty and Profit*, Boston, 1921.

[2] J. Schumpeter, *The Theory of Economic Development*, Cambridge, Mass., 1934. (The Schumpeterian entrepreneur is not only a risk-lover but also an innovator and in those stages a price-maker.)

[3] P. Sraffa, 'The Laws of Return under Competitive Conditions', *Economic Journal*, 1926, pp. 535–50.

[4] This provides partial justification for the assumption of a constraint upon finance in a world of uncertainty.

[5] Op. cit.

rising again as competition from more attractive products becomes severe. Unfortunately for our present approach it is more than likely that in the early stages the price distribution will be positively skew, in the latter negatively skew, necessitating the insertion of the third moment of the frequency distribution in the analysis. Risk-lovers will, however, discount the possible adverse impact of high variance and introduce their new product with but small offsetting dependence on the existing range of products. Risk-averters, on the other hand, will proceed with moderation, allowing the variance of total profits to rise only slowly with at least parallel growth in mean profits. Risk-lovers, of course, will be particularly exposed to loss and liquidation in times of adaptation, but those that successfully negotiate this period will tend to do very well indeed.

Our treatment specifies an exogeneously determined level of finance. In practice this level will be influenced not only by the past successes of the firm registered directly in retained profits and dividend disbursement, but also indirectly through the indication of future profits from latent entrepreneuring effort as revealed by the terms that the market will impose for additional capital. Some placers of funds may be chary of investing in concerns that are heavily specialized and particularly concerned with the manufacture of new products. Individuals and institutions that will take a chance with a portion of their portfolio will back the risk-loving innovators, the more cautious taking the holdings, if at all, indirectly through unit and investment trusts. It is to the study of these more interesting dynamic cases that this paper must be regarded as being no more than introductory.

The implications of this approach—that firms should be treated in similar vein to private investors—for market behaviour, stability of markets, and aggregative analysis remain unexplored, but we can already foresee its potential fruitfulness in a dynamic setting for the assessment of the relative progress of some firms and the retardation of others.

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INCOME DISTRIBUTION IN A TWO-SECTOR ECONOMY

By RICHARD M. DAVIS

THE most familiar model of income distribution specifies two inputs, labour and capital, combined to produce an output which is allocated by the factor suppliers to consumption and investment. The first step in disaggregation is to assume that consumption and investment goods are technologically as well as functionally different. The model is still, of course, highly aggregative in that we are indifferent to or may take as given the composition of the variables comprised in it. This suggests that, if we assume constant returns to scale, each sector may be described as employing a single technique, i.e. fixed ratios of labour and capital to output.[1] After all, as the most elementary proposition in the literature of linear programming reminds us, if there are only two restraining conditions (the amounts of labour and capital) only two processes can be efficiently used, no matter how many may be available. The discussion which follows (except for a brief discussion of an alternative hypothesis, in Section IV below) assumes that the question, 'which two?', has already been answered.

The assumption of a single technique in a two-sector model has quite different implications from those which have been drawn from its application to the one-product economy:

1. It is technologically possible, within fairly wide limits, to employ the available supply of both factors by changing the proportion of investment and consumption goods produced.[2]

2. The growth of the system may be dictated by the factor endowment and technology and not affected by the income disposition decisions.

[1] This is the model which Joan Robinson employs in *The Accumulation of Capital* (London, 1956), especially pp. 73–84. She states in the Preface, p. ix, that the section of the book entitled '"Accumulation with One Technique" . . . contains the most important propositions . . . and the rest of the book may be regarded as complications and qualifications surrounding this central core.'

Standing apart from Mrs. Robinson's work is Paul A. Samuelson's article, 'Wages and Interest: Marxian Economic Models', *American Economic Review*, xlvii (Dec. 1957), pp. 884–912. He discusses (appropriately for his purpose of analysing the Marxian 'prophecies') the original Marxian two-sector model in which capital turns over every period; this means that when growth is called for ('expanded reproduction') its rate must simply be introduced from outside. Avoidance of collapse under these conditions requires constant and equal growth rates in both sectors.

[2] The contrary implication of the assumption of a single technique in a one-sector model has been formally worked out by Robert A. Solow in his 'A Contribution to the Theory of Economic Growth', *Quarterly Journal of Economics*, lxx (Feb. 1956), pp. 65–94. On the inevitable controversy as to who, if anyone, 'really' thought this model an appropriate first approximation to the economy, see Robert Eisner, 'On Growth Models and the Neo-Classical Resurgence', *Economic Journal*, lxviii (Dec. 1958), pp. 707–21, and 'Replies' by Solow and James Tobin, ibid. lxix (Sept. 1959), pp. 597–600.

3. Information about the technology is required, along with knowledge of income disposition functions, to determine the distribution of income.

4. Specification of the income disposition functions requires a measure not only of the quantity of capital, but also of its value, and this information can be drawn from the model.[1]

These properties seem sufficiently interesting and important to justify the construction and analysis of a model which displays them. Since some of them may seem paradoxical and since, indeed, they do not all follow from all possible fixed-coefficient, two-sector models,[2] such analysis is required for the light which it may reflect on not only the particular model in question, but on the whole set of closely related models comprising current macro-economic distribution theory.

I. The Technology

We assume an economy which is endowed with a labour force, L, and a stock of capital, K, of which, respectively, L_1 and K_1 are allocated to the investment sector and L_2 and K_2 to the consumption sector.[3] Designating ΔK as the output of new capital goods during a period of time and W as the output of consumption goods during the same period, we may define the production coefficients:

$$a_1 = \frac{L_1}{\Delta K}; \quad a_2 = \frac{L_2}{W}; \quad b_1 = \frac{K_1}{\Delta K}; \quad b_2 = \frac{K_2}{W}.$$

[1] The question of the necessity of such a measure seems to lie at the root of the controversy between Mrs. Robinson and Solow: see his 'The Production Function and the Theory of Capital', *Review of Economic Studies*, xxiii (1955–6, 2), pp. 101–8, and her 'Reply', ibid. (3), p. 247. She has restated her position more fully in 'Accumulation and the Production Function', *Economic Journal*, lxix (Sept. 1959), pp. 433–42, especially pp. 435–7. She has gained adherents; the point is again made vigorously by R. F. Kahn, 'Exercises in the Analysis of Growth', *Oxford Economic Papers*, xi (June 1959), pp. 143–56, especially p. 144, and by Charles Kennedy, 'A Static Interpretation of some Recent Theories of Growth and Distribution', ibid. xii (June 1960), p. 198.

[2] For example, they do not follow from Samuelson's version, or the original Marxian model, in which the output of one sector is one of the two factors; nor do they follow from Mrs. Robinson's own treatment of her model. (See below, p. 314, n. 1.) The model developed here should also be distinguished from the Leontiev dynamic model, in which the increments of stocks of all resources for any period are the outputs of the system for the preceding period: the essential difference here is that in our model the growth of the labour force is taken as a parameter.

[3] Investment here is net investment. The apparatus outlined differs, therefore, from the famous Marxian reproduction schemes. The sectors of the economy are here defined in such a way that in a state which consumes its entire net output the entire labour force and stock of equipment are employed in the consumption sector. In a stationary state, such as Marx's scheme of 'simple reproduction', the division between 'means of production' and 'means of consumption' is, from this point of view, quite arbitrary, as is any division of the time sequence of stages of production. Labour and capital which are used up in maintaining the stock of capital are consumed; labour and capital which add to the stock of capital are invested. The analysis is simplified, but not basically changed, by thinking of capital as units of immortal machine-and-goods outfits. The assumption that they are transferable between sectors accomplishes the same purpose as the more usual one that they perish physically and are replaced in different form.

The condition for the full utilization of each factor is given by the equations

$$L = a_1 \Delta K + a_2 W, \tag{1}$$

$$K = b_1 \Delta K + b_2 W. \tag{2}$$

To express the results conveniently, let

$$\alpha_1 = \frac{a_1}{a_1 b_2 - a_2 b_1}; \qquad \alpha_2 = \frac{a_2}{a_1 b_2 - a_2 b_1};$$

$$\beta_1 = \frac{b_1}{a_1 b_2 - a_2 b_1}; \quad \text{and} \quad \beta_2 = \frac{b_2}{a_1 b_2 - a_2 b_1}.$$

The solution for the two kinds of output follows:

$$\Delta K = \beta_2 L - \alpha_2 K, \tag{3}$$

$$\frac{1}{K}\Delta K = \dot{K} = \beta_2 \frac{L}{K} - \alpha_2, \tag{3a}$$

$$W = \alpha_1 K - \beta_1 L, \tag{4}$$

$$\frac{W}{L} = \alpha_1 \frac{K}{L} - \beta_1. \tag{4a}$$

The following diagram illustrates the solution. In Fig. 1, vectors $O\Delta K$ and OW are scaled in units of those respective types of output; the inputs for any output are its L- and K-coordinates. The coordinates of P are the existing labour force and stock of capital. Completing the parallelogram between O and P by drawing the dotted lines in the figure gives us OP_1 and OP_2 as the outputs of investment and consumer goods corresponding to full employment of the labour force and full utilization of the stock of capital. The coordinates of P_1 and P_2 indicate the allocation of the labour force between L_1 and L_2 and of the stock of capital between K_1 and K_2. In the next time-period we locate P by the coordinates $OL+\Delta L$ and $OK+\Delta K$, where ΔL is the exogenous increase in the labour force and ΔK is the OP_1 of the previous diagram.[1]

[1] Mrs. Robinson, in *The Accumulation of Capital*, pp. 83–84, and her expositors (e.g. I. M. D. Little, 'Classical Growth', *Oxford Economic Papers*, ix (June 1957), pp. 152–77, and G. D. N. Worswick, 'Mrs. Robinson and Simple Accumulation', ibid. xi (June 1959), pp. 125–43), have chosen to treat the supply of labour as perfectly elastic with respect to the real wage-rate, either in the Malthusian sense in which the labour force is a function of population and the latter is perfectly elastic with respect to some subsistence level, or in the more usual modern sense, in which a given real wage-rate is stipulated by labourers as a condition for entering employment, and full employment (Mrs. Robinson's 'inflation barrier') is not normally reached. This means that income distribution depends upon the stipulated real wage rate and the production coefficients, while employment and the growth rate depend on these factors and the savings propensities. It may be intuitively obvious that in these circumstances the lower the stipulated real wage-rate and the higher the propensity to save the higher will be the level of employment and the rate of growth. (See Little, op. cit., p. 161.) A similar qualitative result, using the Cobb–Douglas model of the production function and assuming neutral and constant technical progress, is developed recently in Arthur Smithies, 'Productivity, Real Wages and Economic Growth', *Quarterly Journal of Economics* (May 1960), pp. 189–205.

From the model developed later in the text, if the real wage-rate (P_L) is stipulated, the

A series of diagrams of the sort described illustrates the time path of the economy. Equation (3 a) indicates the properties of possible time paths. For $\dot{K}$ to remain constant, L/K must remain constant, which means $\dot{L} = \dot{K} =$ constant; for $\dot{K}$ to rise, L/K must rise, i.e. $\dot{L} > \dot{K}$, and

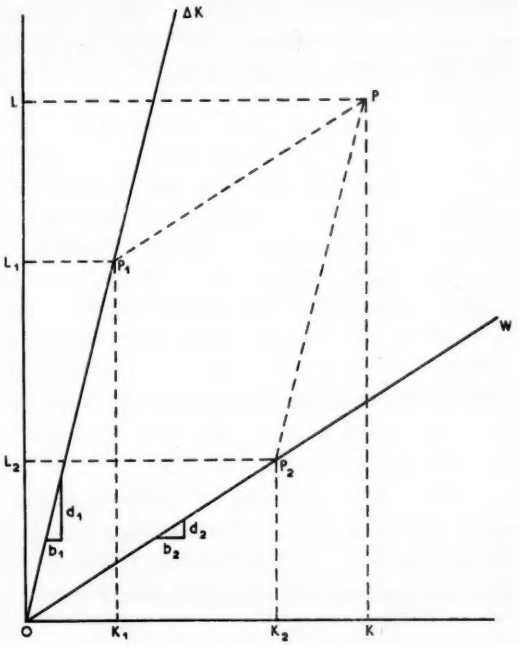

FIG. 1

this means that the labour force must be increasing at an *increasing* rate; for $\dot{K}$ to fall, L/K must fall, i.e. $\dot{L} < \dot{K}$, which means that the labour supply must be growing at a decreasing rate. The inverse of each of these propositions can also be shown.

Two famous, but special, cases of growth paths are those of constant proportionate growth (Mrs. Robinson's 'Golden Age') and zero growth, or the stationary state. If L (our exogenous variable) expands at a

rental of capital (R_k) and the cost of production of capital (P_k) can be found from equations (9) and (10), which involve only the production coefficients. Substituting these values in equation (6) (which adds the savings propensities to our information) and (3) (above) enables us to find growth ($\dot{K}$) and employment (L). For Mrs. Robinson's case, in which labourers do not save,

$$\dot{K} = \frac{S_P(1-a_2 P_L)}{P_L(a_1 b_2 - a_2 b_1)}; \qquad L = K\left[\frac{S_P(1-a_2 P_L)}{b_2\{P_L+(b_1/a_1 b_2 - a_2 b_1)\}}+\frac{a_2}{b_2}\right].$$

These expressions show both $\dot{K}$ and L as increasing functions of S_P (the propensity to save) and decreasing functions of P_L.

constant rate, the proportion of labour to capital will be constant, the ratio depending on the rate of growth of the labour supply:

$$\frac{L}{K} = \frac{\dot{L}+\alpha_2}{\beta_2}. \tag{3b}$$

(Note that this is true *only* when $\dot{L} = \dot{K}$, i.e. when $\dot{L}$ is constant.)

If the labour force remains constant, L/K must continually fall, i.e. $\dot{K}$ must continually fall, reaching its limit when

$$\frac{L}{K} = \frac{\alpha_2}{\beta_2} = \frac{a_2}{b_2}, \tag{3c}$$

i.e. when all labour and capital are employed in the consumers' goods sector. This corresponds to Marx's 'simple reproduction' scheme, which, as explained on p. 313, n. 3, is here treated as a one-sector model. In Fig. 1 the case may be shown by moving P continuously rightward until the vector OP falls on OW. Beyond that point capital becomes redundant.

The opposite case, in which the labour force expands at an ever-increasing rate, requires a rising L/K. Equation (4a) shows a falling output of consumers' goods per head in this case, reaching a limit when

$$\frac{L}{K} = \frac{\alpha_1}{\beta_1} = \frac{a_1}{b_1}, \tag{4b}$$

and full employment is inconsistent with the production of any consumers' goods.[1] It is important to note that in the ensuing discussion of income distribution we are able to use the general assumptions of equations (3) or (3a) and (4) or (4a) and are not restricted to the special cases of (3b), (3c), or (4b).

II. Savings Functions and Income Distribution

The Neo-Keynesian approach to the theory of income distribution consists basically of deriving distributive shares from two equations: total savings from property income and from labour income must equal total investment; and income defined as consumption plus investment must equal income defined as wages plus property income.[2] The expression

[1] If we had assumed the consumer goods sector to be relatively labour-intensive—i.e. if we had reversed the product vectors of Fig. 1—a stationary population selling its labour in a competitive market would face an ever-declining standard of consumption as the society accumulated more and more capital. This would indeed be a thorny path to 'bliss'. However, one attempt to construct a two-sector model which would derive the generally observed positive relation between investment and the profit share from the production functions does rely on this assumption about the relative values of the coefficients in the two sectors. See Ronald Findlay, 'Economic Growth and the Distributive Shares', *Review of Economic Studies* (June 1960), pp. 167–78, and Nicholas Kaldor, 'A Rejoinder to Mr. Findlay', ibid., pp. 179–81.

[2] See Nicholas Kaldor, 'Alternative Theories of Distribution', *Review of Economic Studies* (1955–56, 2), pp. 83–100, especially pp. 94 ff. An extended discussion of Kaldor's theory of distribution is contributed by Michel Falise, 'L'Analyse de la Répartition du Revenu

which Mr. Kaldor has made familiar follows directly:

$$\frac{P}{Y} = \frac{1}{S_P - S_L}\frac{I}{Y} - \frac{S_L}{S_P - S_L}. \tag{5}$$

(P is property income, Y is aggregate income, I is investment, S_P is the proportion of profit, or property income, saved, and S_L is the proportion of wages, or labour income, saved.)

The theory requires that there be a significant difference between the propensities to save out of labour income and out of property income and that I/Y be independent of the savings function. There is no need to catalogue the theories of investment which meet the latter requirement; once we have such an investment function, the savings function yields the distributive shares. So long as income is not technologically decomposed, one needs 'only' an index of its amount and an index of the changing quantity of capital—which has the same physical composition as income. No problem of the value of capital or of its increments is raised and there is no ambiguity in the conception of income to make Kaldor's distribution equation indeterminate.

If we employ the model of Section I, the amount of new capital is given by the technology and the factor endowment. Income is a different matter and can no longer be defined except by a pricing system, since its two components are produced by different factor combinations and, except in the special case of constant growth, vary in relation to each other.

Using consumer goods as numéraire (setting $P_w = 1$), designating the wage-rate in terms of this numéraire as P_L, the net rental of a unit of capital goods per time-period as R_k, and the cost of production of a unit of capital goods as P_k, the two basic equations from which Kaldor's expression for the distribution of income is derived become:

$$P_k \Delta K = S_P R_k K + S_L P_L L \tag{6}$$

and

$$P_k \Delta K + W = R_k K + P_L L. \tag{7}$$

Letting $\eta = \dfrac{1}{S_P - S_L}$ and $\theta = \dfrac{S_L}{S_P - S_L}$,

and solving for R_k by eliminating P_L, we have

$$R_k = (\eta - \theta)\dot{K}P_k - \theta\frac{W}{K}. \tag{8}$$

It is clear that equation (8) is not sufficient to indicate either profit or the profit share. Knowledge of the value of capital (P_k) as well as of its quantity is required. However, the two-sector model which has got us into this difficulty also provides a way out. From the information given

National de N. Kaldor', *Revue d'Économie Politique* (70e Année, Mai–Juin 1960), pp. 393–418, and by Jean Marchal, 'Note Complementaire sur le modèle de Répartition du Revenue National Proposé par Nicholas Kaldor', ibid., pp. 463–529.

in the technology we may define a pricing system which imputes the value of the outputs to the inputs as follows:

$$P_w = 1 = a_2 P_L + b_2 R_k \tag{9}$$

and

$$P_k = a_1 P_L + b_1 R_k, \tag{10}$$

whence

$$R_k = -\alpha_2 P_k + \alpha_1. \tag{11}$$

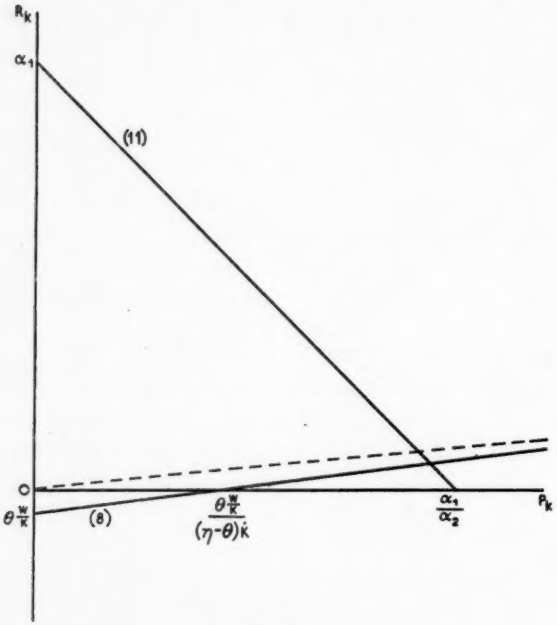

FIG. 2

Equations (8) and (11) can now be solved for both the value of capital and the income per unit of capital (in units of consumer goods) and the distributive shares are determined:

$$P_k = \frac{\alpha_1 + \theta(W/K)}{\alpha_2 + (\eta - \theta)\dot{K}} \tag{12}$$

and

$$R_k = \frac{\alpha_1(\eta-\theta)\dot{K} - \alpha_2\theta(W/K)}{\alpha_2 + (\eta-\theta)\dot{K}}. \tag{13}$$

Equations (8) and (11) with their solution are illustrated in Fig. 2.[1]

[1] Fig. 2 is drawn roughly to the scale of the following example: let the original factor endowment be $L = 1{,}100$ and $K = 1{,}000$; let the production coefficients be $a_1 = 2$; $a_2 = 4$; $b_1 = 1$; $b_2 = 4$. ΔK will be 100, W will be 225, and $\dot{K}$ will be 0·1. Let S_P be 0·9 and S_L be 0·1. ($\eta = 1{\cdot}25$, $\theta = 0{\cdot}125$.) Equation (8) is $R_k = (1{\cdot}125)(0{\cdot}1)(P_k) - (0{\cdot}125)(0{\cdot}225)$ and equation (11) is $R_k = -P_k + 0{\cdot}5$, whence $P_k = 0{\cdot}475$, $R_k = 0{\cdot}025$ and, substituting these values in (6), (7), (9), or (10), $P_L = 0{\cdot}225$.

III. Some Properties of the Equilibrium Income Distribution

Fig. 2 displays properties with which the models of Kaldor and Mrs. Robinson have made us familiar. The equilibrium profit per unit of capital will be the greater the greater the latter's rate of growth ($\dot{K}$). Here, an increase in $\dot{K}$ increases both the slope of the line representing equation (8) and raises its level by decreasing slightly W/K. (From (3) and (4), $W/K = \alpha_1 - (\beta_1/\beta_2)[\dot{K}+\alpha_2]$.) This result is the more interesting in that we have derived it from equations that describe both the savings function and the technology, and the technology is assumed to be relatively less capital intensive in the investment than in the consumption sector.[1] The paradox disappears, of course, when we remember that, first, a higher $\dot{K}$ means, in the technology assumed, a higher ratio of labour to capital (see equation (3 a)) and one may expect relative factor prices and relative factor supplies to move in opposite directions; second, an increase in the propensity to save, which may, under full employment, be interpreted as a shift in the community's preferences in favour of the investment, or less capital-intensive, sector, does have the expected effect of lowering the profit per unit of capital.

The role of saving requires closer examination. Again, from Fig. 2 and equation (8), remembering that

$$\eta - \theta = \frac{1-S_L}{S_P - S_L},$$

we see that the slope of the line representing equation (8) decreases with an increase in S_P and the entire curve shifts downward with an increase in S_L. Kaldor's conclusion appears to follow: wage-earners can increase their share by saving more; capitalists can increase their share by saving less.

The situation is not quite that simple, however, and the conclusion must be qualified. We also see from equation (8) that the slope of the curve in question increases with an increase in S_L and the curve shifts upward with an increase in S_P. To see what this qualification amounts to we may differentiate equation (13) (substituting our definitions of η and θ for those symbols in the equation) with respect to S_L and S_P. It can now be shown that

$$\frac{\partial R_k}{\partial S_P} \gtrless 0 \quad \text{as} \quad S_L \gtrless \frac{a_1 \Delta K}{a_1 \Delta K + a_2 W},$$

and

$$\frac{\partial R_k}{\partial S_L} \gtrless 0 \quad \text{as} \quad \frac{a_1 \Delta K}{a_1 \Delta K + a_2 W} - \frac{(1-S_L)\dot{K}}{\alpha} \gtrless S_P.$$

This means that capitalists can increase their share of a technologically determined output by saving less only if the propensity of wage-earners to save is less than the fraction representing the proportion of the labour

[1] It will be recalled (see above, p. 316, n. 1) that Findlay reaches this conclusion from the opposite technological assumption.

force employed in the investment sector; and wage-earners can increase their share (reduce profits) by saving more only if the propensity to save out of profits is greater than the proportion of the labour force employed in the investment sector less the product of the growth rate of capital and labourers' propensity to consume divided by α (defined above). These conditions are likely to be met for realistic values of the propensities to save and the proportion of the labour force employed in the investment sector, so that our qualifications probably will not alter the tentative conclusion drawn earlier for the role of saving in the model.

The special case in which $S_P = 1$ and $S_L = 0$, which figures so prominently in Mrs. Robinson's book, is illustrated in Fig. 2 by the dotted line, the slope of which is $\dot{K}$.[1] Entrepreneurial income is simply the flow of investment goods made possible by the factor endowment and the technology. If entrepreneurs consume but labourers do not save, the slope of the line representing equation (8) is multiplied by $1/S_P$, the familiar profit multiplier of the 'Widow's Cruse' distribution theories. It is clear that, so long as wage-earners do not save, and $\dot{K}$ is positive—or there is an autonomous element in entrepreneurs' consumption—no amount of entrepreneurial saving can impose losses on the entrepreneurs. In this respect the effects of capitalists' and of wage-earners' saving are not symmetrical; equation (13) shows us that if the wage-earners' propensity to save reaches the critical value $1/\{1+(\alpha_2 W/\alpha_1 \Delta K)\}$ entrepreneurs will make losses irrespective of the level of their own savings.[2]

It was pointed out above that Kaldor's theory of income distribution depends upon the difference between the savings propensities associated with labour and property incomes. His expression for the profit share becomes meaningless for an economy in which that difference disappears. This is not true for a model in which technological differences between the two output sectors are admitted. If we assume $S_P = S_L = S$, equations (6) and (7) yield:

$$P_k = \frac{S}{1-S}\frac{W}{\Delta K} \tag{14}$$

and R_k and P_L can be found only in terms of each other. However, if we permit ourselves the information contained in equations (9) and (10) we may solve for R_k as before:

$$R_k = -\alpha_2\left(\frac{S}{1-S}\frac{W}{\Delta K}\right)+\alpha_1. \tag{15}$$

[1] Only for the special case of Mrs. Robinson's 'Golden Age', in which $\dot{K}$ is constant, will this expression correspond to the conventional rate of return; in other cases it can be so treated only by assuming that entrepreneurial horizons are limited to the immediately passing time-period. (See Kahn, op. cit., p. 145.)

[2] $R_k = 0$, when $\alpha_1(\eta-\theta)\dot{K} = \alpha_2\theta\frac{W}{K}$, or $\frac{\eta}{\theta} = \frac{1}{S_L} = 1+\alpha_2\frac{W}{\alpha_1\Delta K}$.

In Fig. 2 a vertical line representing equation (14) may be substituted for equation (8) and the intersection gives us the solution as before. An increase in the value of S moves the vertical line to the right, yielding smaller and smaller values of R_k.

IV. Technological Progress

Neutral technological progress can, of course, be interpreted in the model described here—as well as in others—simply by a scale change, and produces no difficulties. Not-quite-neutral progress, in which different scale changes are introduced in the two product vectors so that a_1/b_1 and a_2/b_2 remain unchanged but a change does occur in a_1/a_2 and b_1/b_2, will change the rate of growth and pattern of income distribution, but will involve no change in the interpretation of the model.

If a technological change is introduced which requires entrepreneurs to choose between two available techniques (e.g. a new product ray OW is introduced with slope a_3/b_3) the output combination can no longer be determined from the factor endowment and technology. However, we may add to equations (9) and (10) a third equation of the type

$$1 = a_3 P_L + b_3 R_k;$$

we now find that the prices and consequent distribution of income are determined by the technology. To find the allocation of output between consumer goods and investment goods and the consequent growth pattern of the economy we may substitute those prices in equations (6) and (7) and solve for ΔK and W. We now find ourselves back in the neo-classical world in which income distribution is determined by the production functions while the composition of output and consequent structure and growth of the economy are determined by the preference (thrift) patterns of the community.

V. Disequilibrium

The two-sector model described here avoids the 'razor-edge' type of instability which Solow has analysed for the one-sector model employing fixed proportions.[1] Within a wide range of production possibilities it is possible to specify prices which will clear factor and product markets. It is also possible to suggest many plausible sequences of behaviour on the part of entrepreneurs and households which would prevent such an equilibrium from being reached and which might involve cumulative disequilibrium, or less-than-full employment equilibrium or some sort of cyclical pattern. Mr. Kelvin Lancaster has recently criticized Mrs. Robinson for employing the literary method in describing such sequences and for failing to point out the very large number of possible sequences which

[1] See above, p. 312, n. 2.

a specifically dynamic econometric model would have made apparent.[1] The present treatment is restricted to translating the price disequilibrium situations suggested by the model into the savings-investment disequilibria that we are more accustomed to discussing in aggregative models.

Referring to equations (6), (7), and (8), we note that P_k may be interpreted as the (intended) savings per unit of new capital which will correspond to any specified return per unit of capital, R_k, or related real wage-rate, P_L. In like manner, from equations (9), (10), and (11), we may interpret P_k as the investment, valued in consumer goods, required per unit of new capital formed for any specified return per unit of capital or corresponding real wage-rate. The intersection of the two curves of Fig. 2 is, therefore, a savings-investment equilibrium. The horizontal gap which emerges with a 'too high' R_k (e.g. if entrepreneurs insist upon a minimum return per unit of new capital and refuse to purchase new investment goods if they do not expect to obtain such a return) corresponds to the excess of (intended) savings over investment familiar in Keynesian analysis.

If we had eliminated R_k instead of P_L in solving our two sets of equations we should then have saving and investment per unit of new capital as respectively decreasing and increasing functions of the real wage-rate. In this case, a 'too low' real wage-rate (e.g. if oligopoly in consumer goods is not fully offset by oligopoly in labour markets—the case which Mrs. Robinson stresses) may also be interpreted as an excess of saving over investment for the level of capital formation which the technology and available factor supplies require.

VI. Conclusion

One's impression of the relevance to the economy of a model of the sort outlined here depends on one's confidence that (1) the output of the economy can be realistically separated into growth and consumption-plus-maintenance sectors—i.e. there is some meaning in the notion of net investment; (2) there is some meaning in the notion of a quantity of capital and quantity of labour as distinct from their respective prices; (3) the ratio between the amounts of these two factors per unit of output in the two sectors is significantly different and reasonably stable. The model is offered here—with somewhat more confidence—as an exercise in the interpretation of an important segment of contemporary economics.

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[1] 'Mrs. Robinson's Dynamics', *Economica*, N.S., XXVII (Feb. 1960), pp. 63–70.

INTERNATIONAL TRADE AND TECHNICAL CHANGE

By M. V. POSNER

THE purpose of this paper is to present an explanation of trade in manufactured goods between advanced countries which share very similar general economic conditions. The paper suggests that trade may be caused by technical changes and developments that influence some industries and not others; because particular technical changes originate in one country, 'comparative cost differences' may induce trade in particular goods during the lapse of time taken for the rest of the world to imitate one country's innovation. It is claimed that for various theoretical reasons such a model may be better suited to explain substantial parts of world trade than some alternative models, but the main aim is to add to rather than replace the range of explanations available. The discussion is purely theoretical, in that none but the most casual attempts have so far been made to provide empirical verification for the assumptions of the model.

A. Introduction and Assumptions

Some considerable attention has been given to the interaction of economic growth and the trade balance, and to discussions of the impact of changing relative factor endowments on trade patterns.[1] The common analytical framework of most of these approaches[2] is the Ohlin–Heckscher model. There are a number of reasons why such models, leading to elegant analysis and interesting conclusions, may not provide the whole answer to the questions at issue.

First, new commodities are developed through time. In principle, this difficulty is not insurmountable—the usual solution is to value the new commodity as some fraction of an old commodity. The fact that important discontinuities may exist (e.g. the development of a new commodity may reduce the value of its old substitute to zero), or that demands for goods may not be mutually independent (e.g. the new product displaces a whole range of jointly consumed but technically dissimilar products), makes the analysis more complex but does not change its essential nature. But the development of new products does not occur simultaneously in all countries—in most cases the only reason they are introduced is because the

[1] Cf., for example, H. G. Johnson, *International Trade and Economic Growth*.

[2] With the exception of, *inter alia*, papers by R. Robinson, 'Factor Proportions and International Trade', *Quarterly Journal of Economics*, 1956; and I. B. Kravis, '"Availability" and Other Influences on the Commodity Composition of Trade', *Journal of Political Economy*, 1956. Thomas Balogh, in several articles to be reprinted in his forthcoming book (*Unequal Partners*), has frequently hinted at the sort of analysis developed in the present paper.

entrepreneur concerned is hoping to achieve a quasi-monopoly for a period of time. During this period of time a cause of trade exists which is independent of any of the previously existing comparative cost differences. In so far as the process of growth implies continuous technical progress, the effect of economic growth is to develop a cause of trade *sui generis*.

Secondly, we must recognize that even if new products are not developed, new processes may be, and such new methods will give the country concerned a comparative advantage in some goods. But this cause of trade will infringe an important condition of the Ohlin model—that production functions are identical in all countries. Trade, then, may be caused by the existence of some technical know-how in one country not available elsewhere, even though there may be no international differences in relative endowments of factors of production *strictu sensu*. Thirdly, there is the problem of the rate of generation of technical progress and its relation to changes in the conventional factors of production; is the generation of new 'know-how'[1] correlated with the rate of investment? And lastly, will the stream of innovations be randomly distributed between industries, or in some way biased, in any particular country, towards one sector?

For these reasons, it seems worth while to attempt to analyse those aspects of trade in a changing world that do not come neatly under the umbrella of traditional analysis. To do this, we will start by assuming away Ohlin-type differences between countries; we will later distinguish the model here presented from one based on static economies of scale.

1. Differences in Factor Endowment

The Ohlin model rests on differences in relative factor endowments; we must therefore assume that, in some sense, all factors of production exist in equal proportions in all countries of our trading world. On the other hand, we necessarily allow the existence of different types of machine and different operations by labour in different countries. The problem of definition of factors, therefore, is crucial to our discussion. Clearly we may say that two countries have identical factor endowment if the full employment output of one country could just be produced by the factors of the other country, when those factors are fully employed and are using precisely the same techniques as the first country. But for our model, we must also be able to say that two countries have the same factor endowment even if, at any point of time, country A is unable to produce country B's output, provided that such an adaptation of A to B's superior technique would take place after a lapse of time that we shall call the *learning period*.

[1] J. Downie, in his book *The Competitive Process* (p. 88), defends the use of this term on the grounds that 'The very fact that the barbarous neologism has crept into the language points to the existence of something . . . [which is not] "capable of being written down and taught by professors".'

This presents some problems of definition, but also some issues of importance (which we discuss below).

There are two possible sets of definitions that will enable us to achieve our aim—which is to abstract from all causes of trade other than those in which we are interested. The *first* is unconcerned with international differences in both the value of capital and its physical composition (and avoids also, thereby, problems of *measuring* capital); each country in our trading world, we would assume, has (initially) the same rate of profit, the same rate of growth,[1] the same wage rate (for homogeneous labour), and the same rent per acre of (homogeneous) land. A model built on these assumptions can permit with complete ease international differences in the physical composition of output and (somewhat less easily) associated differences in the inter-industry pattern of costs, prices, and rates of growth.

A second, alternative, model would recur to the concept of a learning period, in an attempt to make a clear distinction between two capitals whose values are 'identical' but are not at the moment interchangeable and two whose lack of interchangeability is due to the non-identity of their values. But a learning period implies time for adjustment, and time spent in this way is itself a form of investment. It follows that trade caused by differences in technical knowledge could not easily be separated from trade caused by differences in factor endowment. Moreover, since we will be considering later, not only the results of a once-for-all difference in technical knowledge, but also of differences which are repeatedly renewed through time, such a systematic confusion would seem to be more confused, because the continued supply of fresh knowledge at a faster rate in one country than in another is likely to be closely associated with a higher rate of net investment.

But the essence of the present model is that the temporary advantage in knowledge assumed is specific to one industry; for one industry, differences in technical knowledge may be very great, while aggregate differences in capital endowment may be very small. In such cases the problem of the meaning and measurement of capital may be ignored, because, for an individual part of capital (that in a particular industry), it will in general be possible to make a sharp distinction between differences in technique that can be imitated after a (finite) learning period, and those that require a period of heavy investment.

On either of these two approaches, therefore, A and B may have identical factor endowment but different productions—if knowledge flows freely,

[1] We shall later wish to allow our model to generate rates of growth that differ between countries because technical progress is faster in one country than in another (although this is not central to the model).

after the lapse of a learning period, factors will be adapted to new uses, and A and B become identical economies. Whatever difficulties there may be in these assumptions arise solely, I would claim, from a lack of clarity in selecting them, for there must be *some* set of consistent assumptions that enable us to abstract from those international differences which we do not wish to consider—i.e. from differences in the endowment of 'the factor of production capital'.

2. Industries and Firms

We must assume that all industries exist in all countries, even though differences in technical knowledge will induce differences in processes or products between two (identically named) industries in different countries. The purpose of this assumption is to reinforce the definition of a learning period given above. If there were no counterpart in country A of the innovating industry in country B the learning period might be infinite—no entrepreneur in A would be skilled or equipped to imitate, and no incentive to imitation would be felt by any particular entrepreneur. But to make this assumption we have to define an industry.

The definition follows naturally from the purpose for which we intend to use it. An industry consists of a group of firms who have equipment and a labour force which are rapidly adaptable to the production of each other's output, but which are substantially less well suited to the production of 'outside' commodities. To assume the existence of industries in this sense, therefore, is to assume that if we range $(n-1)$ firms according to the ease with which they could produce the nth firm's output, there will be a substantial discontinuity in such 'elasticities of substitution', marking off from all others those firms who are in the same industry as the nth firm.

3. Other Assumptions

Lastly, we make a set of usual assumptions: tariff barriers are zero; consumer tastes are identical in all countries, and are either stable or, if they do change as new possibilities are presented to them, any change is identical in all countries; international exchange rates are fixed; full employment exists before any trade starts, and there are, at the domestic level, forces acting to maintain full employment through time—'stable growth'; and, except where otherwise specified, transport costs are zero.

B. How Many Factors of Production?

Before we actually examine the working of this model, we must briefly examine two alternative explanations of the sort of trade in which we are interested, and relate these explanations to our own. In the next section we discuss economies of scale, while in this we question the validity of

a many-factor model for an analysis of trade which takes place between countries equally endowed with land, labour, and 'capital'. Such a model could be constructed either by subdividing one of the basic three factors—usually labour ('skilled', 'unskilled', 'agricultural', 'industrial', &c.), or by adding to the list other 'quasi-factors' ('managerial ability', 'engineering ability', 'initiative', &c.). The greater the number of 'factors' the more likely it is that any two countries will be unequally endowed with them; thus, as we increase the number of factors, more and more trade is 'explicable'.[1]

But, of course, the adequacy of an explanation decreases as it becomes merely a description of what is the case; explanation, in this context, must consist of an account of the causes of which the observed phenomena are the result, or perhaps in an account of the processes through which trade has been generated. The objection to a many-factor model of trade is not only that the 'multiplication of entities' that it performs is unnecessary, but also that it is logically an unsatisfactory structure; fundamentally the problem is that 'factors of production'—producing agents imperfectly substitutable for each other—must be relatively few in number if the term is to remain meaningful.

If n commodities are produced it may well be that the services rendered by a factor of production (say labour) are of a different sort in each line of production; n separate 'industrial classifications' of labour may therefore be distinguished. It would follow that if the n commodities were produced in different proportions (but under constant returns) in two countries, then, necessarily, the two countries could be said to be differently endowed with labour of different industrial classifications. But (quite apart from problems of the doubtful temporal priority of the difference in endowment), this explanation of trade would be useful only if the actual labour concerned were imperfectly versatile between different classifications. The fact that a worker (or machine tool) performs different operations in two occupations, is no reason for arguing that he is a different factor in the two occupations.

Because much capital equipment (physical objects) is specific in the services it may render, it might seem quite acceptable to allow that each line of production uses its 'own' *capital* sub-factor. But here problems of time and causation are insurmountable; for the physical shape which capital assumes is the *result* of demand patterns—not, except in the short run, a *cause* of cost differences between countries. Of course, trade, like all other economic events, is a short-term phenomenon, and a short-term explanation is *déjà quelque chose*. Why, to consider a traditional example,

[1] This matter is discussed in P. A. Samuelson, 'International Trade and the Equalisation of Factor Prices', *Economic Journal*, 1948.

does Switzerland export watches? We could reply that it is because 'Switzerland' is differentially well endowed with 'labour skilled in watch-making', or, alternatively, with 'watch-making machinery'.

There are three reasons for rejecting this formulation; first, if it were the mere existence of watch-making machinery that led to profitable operation of the industry, foreign entrepreneurs would soon provide similar machinery abroad—why not 'run-in' watch-making just as profitably as, say, camera manufacture? In other words, the objection to multiplying entities is that the model thus proposed can explain only an *unstable* equilibrium—one that will be destroyed by any chance disturbance.[1] Secondly, such an explanation fails to account for the original establishment of an advantage in one country. It is the aim of the model advanced in this paper to provide precisely such an explanation of the process of generation of comparative advantage through time.

Thirdly, to use the concept of a factor of production in this way is to make it a catch-all, an envelope term; to explain trade by a differential endowment of sub-factors may be merely to affirm one's faith in the possibility of an explanation within the framework of the Ohlin model. In the case of 'Switzerland', what forms could different endowments take? A general willingness of apprentices to be trained in the appropriate skills; a willingness of machine-tool manufacturers (conveniently close at hand) to consult on production problems; a constantly renewed group of entrepreneurs who have spent their life in the business; &c. They are, so to speak, factors of production generated (or constantly renewed) by the productive process in which they are afterwards utilized. But is it possible, even in principle, to measure the existence of such differences except by the wholly circular method of taking the existence of the comparative cost differences as proof of differences in endowments? Despite this circularity, it is relevant to include such quasi-factors in our analysis; however, we will analyse the process of their *generation* as well as their effects on trade.

C. Dynamic and Static Economies of Scale

The assumption of economies of scale seems ideally suited to just those cases where a many-factor model is most open to question. If, for reasons of historical accident (which we investigate in subsequent sections), the production of a commodity whose output is subject to economies of scale is begun in only one plant, and if the market is so small that it can be saturated before these economies are exhausted, then there is no reason why more than one plant should ever be built; and if competition does

[1] Even labour skills can be encouraged by a period of protection—to be skilled in an occupation often means no more than having experience in a particular post. But doubtless background conditions of this sort are more stable *causes* of trade than mere differences in types of machinery.

develop, only very strong oligopolistic combinations will resist ultimate elimination of all competitors save one. On this argument, international trade in many manufactures may be characterized by complete specialization—even if economies internal to an individual plant are soon exhausted, those *external* to the plant, but internal to a group of plants (within one country), may still be available.[1]

Such a model surely explains much trade that does take place. But it raises, and leaves unanswered, some important questions. First, what was the cause of the 'historical accident'? Secondly, why, if we take account explicitly of technical progress through time, does a pattern of specialization once established often persist despite technical developments in the nature of the product and the manufacturing process? (Equally in need of explanation is the reverse effect; the rapid and unpredictable *changes* in the pattern of specialization that take place in the production of many manufactured goods.) And thirdly, it does seem that many commodities that are traded are not produced under economies of scale—machine tools, for instance are not mass-production goods. Thus we neglect in our model trade that depends on static economies, although in the real world this source of trade will in general be closely intermingled with that which we are here discussing.

We try to solve these questions by defining a concept which we call 'dynamic economies of scale'. Where technical progress occurs, unit costs for a particular firm are lower today than they were yesterday (*a*) because of general technical progress during the lapse of time; (*b*) because this particular firm can now draw on its experience of yesterday's production; and (*c*), because this particular firm develops new methods independently of its previous experience in this line of output. It is type (*b*) that we call *dynamic economies of scale*.[2]

Static economies and technical progress of type (*a*) may be enjoyed at a point of time by all firms in all countries. Dynamic economies (type (*b*) cost reductions)—and also the more random type (*c*) cost reductions—are specific to a particular firm. In certain industries at certain points of time such 'know-how' is overwhelmingly important; at other times and in other industries it will be less important than those increases in pure knowledge which are freely available to all firms. We argue in Section F below that

[1] Complete specialization is not necessary even on these assumptions, since the international market may be large enough to support two optimally large industries, one in each country; because of differences in size of the countries, or genuine differences in tastes, one industry may be an exporter of its 'surplus'.

[2] We may formulate somewhat more precisely the concepts explained above. A general mathematical treatment would require to define a single function (a sort of production function) relating unit costs to time, past output, technical progress, &c.; the various partial differentials obtained by differentiating the function could then be related to the concepts in which we are interested. Since, however, we do not intend to manipulate such a function for the purposes of this paper, we may formulate, for purely expository purposes, a number

it is the relative importance of technical progress of types (*a*), (*b*), and (*c*) that determines whether comparative advantage is stable or unstable through time.

D. Domestic and International Competition

The central idea of this trading model is very familiar and of quite general applicability. If one firm, which happens to be situated in northern England, introduces a new product, demand for which effectively replaces demand for the old product, then other firms in this industry, situated in the south of England, will find their markets threatened.[1] The more *competitive* the industry (the more homogeneous the output of the industry

of different functions, each of which corresponds, on its own, to one of the different types of economies of scale.

Let C = unit costs,
P = numbers produced,
t = time,
and T = the particular point of time under consideration.

Then we may express the assumption that *static economies of scale* prevail by writing

$$C_t = f(P_t), \qquad (1)$$
$$\left(\text{when } \frac{dC_t}{dP_t} < 0\right).$$

To the extent to which *technical progress of type* (*a*) (which is freely available to all firms) is the rule, and if we neglect all other influences on costs, we may write

$$C = f(t), \qquad (2)$$
$$\left(\text{when } \frac{dC}{dt} < 0\right).$$

Dynamic economies of type (*b*) (if we again neglect other functional relationships) may be expressed thus:

$$C = f\left(\int_0^T P_t . dt\right), \qquad (3)$$
$$\left(\text{when } \frac{dC}{dP} < 0\right).$$

Randomly generated cost reductions of type (*c*) may be formulated in the following way:

$$C_{it} = f(\epsilon_t),$$

where the subscript refers to the ith plant or firm, and ϵ is some random term.

Expression (3) suggests that costs today will be equally influenced by a high level of output yesterday and a high level 50 years ago. This is clearly unsatisfactory, but some method of weighting more heavily the recent past could easily be incorporated; e.g.

$$C = f\left(\int_0^T w_t P_t . dt\right),$$

where $w_t = \phi(t) > 0$ and $\phi'(t) > 0$.

I am indebted to Professor Meade for help in clarifying the concept of dynamic economies of scale.

[1] Alternatively, the innovation could cheapen the production of a good that remains itself unchanged. Our analysis relies, not on new products, but on new production functions: we stress the case of product innovation because it is more complex and general.

before the innovation) the greater will be this threat; and the more *cohesive* the industry (the greater the adaptability of one firm's equipment to another firm's output) the greater will be the possibility of the southern firms imitating the northern firm.

The incentive to such imitation will be the greater, the greater the capacity of the northern firm to expand its output sufficiently to swamp the southern market. Such expansion would require new investment (unless, by chance, the northern firm was about to replace depreciated equipment, and the innovation was 'capital-saving': a possibility we shall neglect). It is true that this investment will bring about an Ohlin-type difference in factor proportions, but this will be the *result* rather than the *cause* of trade. (Moreover, a southern firm in a different industry may in general be investing for quite different reasons, and therefore the relative endowments of north and south need not be changing.)

Imitation must eventually occur if the southern plants are to stay in the industry. They will stay, unless the northern innovation is such that it effectively shifts the northern firm from the industry to which it had previously belonged. If the innovation is of this sort—e.g. the development of artificial fabrics—then the southern firms need have no particular incentive to follow the northern firm's development, and may move to some quite different industry; we may describe such cases by saying that the learning period would be too large to make the imitation worth while.[1] The learning period is a technological concept, but the time actually taken for an imitation will depend both on the learning period, and on an (economic) *reaction lag*, which will be the greater the less the degree of competition in the industry. The sum of this learning period and the reaction lag we may call the *domestic imitation lag* in our system.

In so far as extra capacity is created in the north before the expiry of the imitation lag, the southern firms will have less hope of successful imitation; on our assumptions the *best* they can do is to copy exactly the new techniques (or to reduce their costs to the new low northern level), and to the extent to which the market is now saturated they might think it better to 'change industry'.[2] But the greater the willingness of the market to absorb the new product, and the less rapid the expansion of capacity in the north, the less important will be this effect.

[1] This implies that the degree of adaptability of equipment to new methods can be completely described by the time required for such adaptation. Such a usage is appropriate if we assume that the innovations in question can be introduced without the production of any new physical equipment—thus effectively only learning (a process whose cost is completely identified by its time dimension) is required. This assumption is a useful simplification.

[2] This is an argument analogous to Professor Meade's treatment of the infant industry argument for protection. Cf. J. E. Meade, *Theory of International Economic Policy*, vol. ii, pp. 49–51.

During the imitation lag,[1] to the extent that northern capacity does increase,[2] there will be a 'trade disequilibrium' between north and south, for the north's exports will increase (or imports decrease). Provided that a return to full employment is made, the 'deficit' may be wiped out by southern imitation and retention of markets; or, alternatively, the southern firms may change industry, and (assisted by a general increase in effective demand of which the original innovation is the cause or occasion), find a new use for their resources.

Innovations affecting only single products, in an industry where multi-product firms predominate, present an interesting special case. The switch of one firm's capacity to the standardized production (by a new technique) of one commodity will automatically leave unsatisfied those customers who had previously purchased other products from the innovating firm: and this market (often a relatively unprofitable one) will fall to the backward firms. Here the incentive to imitation is in part the fear that the innovating firm will in time use its new technique for the production of other goods in newly built plant.

So far this is nothing more than the familiar story of the spreading of innovations in a competitive economy. To apply this account to an international (for simplicity, two-country) economy we have to make the following changes:

1. The reaction lag, a component of the imitation lag, took account of the degree of competition in the combined north–south industry. In formal terms it may seem that such a concept is also all that is required, in a properly international model, to measure the speed of reaction to international competition. But, even formally, we have *n pairs* of industries, and the degree of competition *within* each industry separately is not necessarily identical with the degree of competition *between* each native industry and its foreign counterpart. Thus we must use the reaction lag to measure the response of a firm to the possibility of competition, in its domestic market, wherever that competition comes from; and define the *foreign reaction lag* as that time which elapses between the successful utilization of an innovation by one firm in the foreign country and the new good's becoming regarded, by producers in the domestic market, as a likely competitor on the same footing as a domestic product.[3] For an international model, then, the (international) imitation lag has three components which are encountered in the following order: the foreign reaction lag, the domestic reaction lag, and the learning period.

[1] We omit the word 'domestic'.

[2] A certain amount of increase in capacity is necessarily implied by some cost-reducing innovations.

[3] Evidently this new lag could be negative; home producers may react more readily to foreign than to home competition. If substantially negative lags were the rule, the present model would be to that extent vitiated.

2. This foreign reaction lag lengthens the imitation lag, but there is an analogous effect which delays the successful *sales* of the innovated foreign products on the domestic market; new foreign goods may not be regarded, for some reason, as perfect substitutes for home-produced goods until some time elapses. This '*demand' lag* may be large enough to outweigh not only the foreign reaction lag, but indeed *all* the components of the imitation lag: in such circumstances, trade would not take place at all. The demand lag is encountered only in international trade, and arises (like its strict counterpart on the imitation side, the foreign reaction lag) from the mutual separation of national markets. The existence of frontiers, then, may influence both the challenge of new goods, and the response to competition.

There are two possible relationships between demand and foreign reaction lags. On one hypothesis, the size of the two lags would be very similar: the more slowly the sales of a new foreign product could be promoted in the domestic market, the less the incentive to imitation, and vice versa. Somewhat differently, we might assume that producers reacted not to actual competition, but to potential competition—that, for example, the foreign reaction lag could be much smaller than the demand lag if domestic producers were more alert to foreign developments than were foreigners to the possibilities of their export market. On this second hypothesis, which is the one we favour, the correlation between the two lags may still be positive, but not particularly strong—some producers may be brighter than others. In some circumstances, then, imitation might occur without the original innovation generating any trade at all.

3. Our assumption that there existed the conditions for stable (full employment) growth internally, implied that inter-regional imbalances ('on current account') would disappear; we made this assumption in order to abstract from problems to the solution of which this paper has nothing to add. But to make an equivalent assumption about the international economy would be to abstract from perhaps the most important *distinguishing* characteristic of international trade—payments problems.

There is a slight problem of method here. The discussion has been deliberately centred on micro-economic relationships, and hence the assumption that total demand is sufficiently buoyant to allow one firm to find a net additional outlet for its products has seemed innocuous. Similarly, even in international trade, the deficit caused by one innovation cannot be thought significantly to reduce the possibility of one firm replacing its lost domestic market with another. To the extent to which international trade were small relative to internal trade (or, in the internal model, if innovations were small in number and functionally independent of all other production flows) this neglect would be pardonable; and it would be unnecessary to discuss it if there were reason to assume the

existence of such mechanisms as would tend to maintain a stable equilibrium at full employment. Since neither of these escape routes are open to us, we have to take account of employment- and income-effects, even if the size of these effects for each *individual* innovation and trade flow may be small.

It is the separation of national monetary systems and capital markets (very broadly defined) from each other that makes partial equilibrium analysis so inappropriate for dealing with international trade.[1] Surpluses earned by one region are not (even if spent rather than hoarded) distributed randomly. If they were, it would be possible to conceive of some market mechanism that would guide excess demand to the site of excess supply. But because of the imperfection of the world capital market, and the associated partial insulation of monetary systems from each other, payments deficits do occur; and these difficulties, in a familiar way, are to some extent aggravated in so far as full employment is maintained in the deficit country.

We require, therefore, an explicit assumption about the domestic and international reactions of the deficit and surplus countries to the employment and balance of payments consequences of innovation. The assumption that we make is that the adjustment takes place by the revision of the relationship between the general price levels of the trading countries; thus we steer a way between the Scylla of employment changes and the Charybdis of partial equilibrium analysis (changes in the prices of particular commodities). Effectively, therefore, we assume some ideally smooth form of adjustment through devaluation, neglecting all the practical and theoretical difficulties of such a step.

E. The Model

Trade, on these assumptions, is generated by differences in the rate and nature of innovation in different countries.

We have the following parameters:

the foreign reaction lag	l_1
the domestic reaction lag	l_2
the learning period	l_3
Then the total imitation lag	$L = l_1+l_2+l_3$
Further we have the demand lag	λ
and the net lag	$(L-\lambda)$

(all measured in time units—e.g. 'months')

[1] Many important international problems can arise also between regions. But (*a*) inter-regional problems will not be purely *monetary* in their form; and (*b*), whereas cumulative *inter-regional* disequilibria occur most typically between an industrialized and an agricultural region, *international* disequilibria may occur between highly industrialized and rapidly growing countries.

There is an L and a λ appropriate to each industry; the absolute size of these two lags and their size relative to each other will vary from industry to industry.

Suppose that, starting from a position of no-trade equilibrium, a firm in a particular industry in one country develops a new product, displacing its nearest competing good at home. Consider the effect of this on a second country. After a demand lag appropriate to this country and this industry, the new product will begin to be imported, and will continue to be so until the total imitation lag has expired.

Suppose that the value of imports per 'month' is a constant;[1] then during the period of 'months' between the expiry of the demand lag and the expiry of the imitation lag there will be a constant imbalance on current account. If the imitating country's entrepreneurs in the relevant industry are particularly quick at imitation, the reaction lags may be very small; and if the learning period is also small, it may be that the imitation lag is smaller than the demand lag; in this case there will be no trade. The same might occur if differences in 'tastes' between two countries were very large.[2]

On the other hand, the imitation lag can be so large that the deficit (surplus) continues for a long time: this would be so if the new product (or, more likely, process) required a resource which was peculiar (for a period of time) to the innovating country. More generally, the reaction lags may be large because of entrepreneurial inefficiency; and the learning period might be exceptionally long because of the nature of the innovation.

Each flow of (one-way) trade, then, is in general finite, and depends on the speed of imitation relative to the demand lag. But our system can yield (if we forget for the moment compensating mechanisms) a constant flow of one-way trade, if we assume not just a single innovation but a *flow of innovations* through time, first in one industry, then in another. If we assume that the net lag and the flow of trade it causes are the same for all industries, we obtain a constant rate of flow of trade per 'month', if the innovations are utilized at a rate equal to one every $(L-\lambda)$ months. No sooner, we assume, does one industry in the imitating country 'catch up' than the next is in turn struck by an innovation originating in a foreign competitor.

If we allow both the net lag and the innovation's 'importance' (the

[1] More realistically, no doubt the rate of import would vary during the period $(L-\lambda)$—probably increasing through time. This complication could no doubt yield interesting special cases if fully analysed, but seems to have little general importance.

[2] The likelihood of this is less if producers' goods or processes are being innovated rather than consumers' goods, since there is more similarity, in the real world, although not on our assumptions, between production functions than between consumers' tastes.

amount of trade per month it causes)[1] to vary between industries, the rate of innovation required for a constant flow of trade can no longer be defined by a simple term, and will vary from time to time (within 'months' as well as between them) and according to which industries are innovating in the period in question. But there will be at least one pattern of innovations through time that can lead to a constant flow of trade.

Long before such a constant flow could be established in the real world, of course, some sort of reaction will have been stimulated in (at least) the importing country. But, still using innovations as the only stimuli to individual importers and exporters, our model can generate a stable equilibrium of two-way trade; country 'Two' can innovate as well as imitate, and country 'One' can imitate as well as innovate.

Assume first that the 'net lag' in an industry and the 'importance' of an innovation are the same, not only for all industries, but also in both countries. Then a steady flow of balanced trade will occur if the rate of innovation is identical in the two countries and equal to the constant rate of one every $(L-\lambda)$ months. But trade can continue to be balanced for each 'month' (though not necessarily within each 'month')[2] whatever the rate of innovation, provided only that the rate is the same in the two countries, and that, when country One innovates in one industry, country Two innovates in some *other* industry.

If the values of the relevant parameters differ from industry to industry and, for each industry, between countries, then there will be no simple unique rate that will maintain an equilibrium of trade through time, and, indeed, it will no longer be possible unambiguously to compare *the* rates of innovation in different countries nor to determine their effects on trade. The ambiguity is twofold. First, in computing the relative rates of innovation of two countries, we have to aggregate the rates in different industries. The weights we use for this aggregation must be the set of parameters (which we called 'importance') that determine the impact of these innovations on foreigners. But, if these parameters differ between countries and industries, which country's set of weights should be used?

[1] 'Importance' depends partly on the relative weight of the industry in question in the composition of gross national expenditure, and partly on the elasticity of demand for the new product or cheapened production process. An industry's 'importance' may well vary through time, but we assume that the rate of change of importance is small compared with the rate of innovation within any particular industry. If this assumption did not hold, then the whole concept of an industry would be *ipso facto* otiose. In the real world, one suspects that at some times in some 'industries' technical change bursts the bonds of specific industries, and that therefore firms, or even plants, rather than industries are the counters with which we should play. At other times and in other sectors of the economy, the assumptions of the present model may be appropriate. If industries are changing relatively rapidly, then 'importance' is determined by the innovation, not, as we implicitly assume, predetermined by the importance of the industry before the change takes place.

[2] A point of some importance for policy discussions. It is not analysed in this paper.

Secondly, even if this index number problem is avoided, the value of the net lag, and therefore the *effect* on trade of a given pair of innovation rates, may differ between industries and countries.

It is true that the net lag is analytically separate from the concept of the rate of innovation, but, in order to evade these sources of ambiguity, we may usefully combine the two concepts into one: that of dynamism:

Given the values of the relevant parameters, country One is more *dynamic* than country Two if, considering only trade caused directly by innovations, country One maintains a net surplus during a period of time.

In the general case, then, two equally dynamic countries (rather than the two countries 'innovating at the same rate' of the simpler case) will enjoy trade without (long-run) balance of payments difficulties. But the conditions for the existence of equal dynamism are much more restrictive even than those for equal rates of innovation, and it is clear therefore that we have to allow our model to react to surpluses and deficits that are large and continued; we assumed above that the reaction to any balance of payments problem, whatever its source, would be devaluation (or some move with identical relevant consequences) by the deficit (i.e. the less dynamic) country.

The result of this change in the price levels will be that *all* commodities will be cheaper in the less dynamic country, and some or all of them[1] will be traded. Thus, in this model, the dynamic tail wags the static dog: because of differences in the degree of dynamism between countries, and the consequential imbalance in dynamic trade, trade in ordinary 'static' commodities (producible at a point of time in both countries) is induced.

But will our smooth adjusting mechanism work? And how long will it take to work? The deficit country is not asked to make a once-for-all adjustment, but a continuous one; the difficulties in such a situation are notorious and require no further stressing in this paper. We permit ourselves one policy comment: the 'gains from trade' generated by this model are identical with the 'gains from growth'. A trading country gains over its autarchic counterpart by benefiting from technical progress rather earlier—foreign as well as domestic gains are available. This is a clear advantage; but how silly it would be, in a trading situation of the sort we describe, to sacrifice internal growth for external trade, particularly as a lack of dynamism was the original cause of the balance of payments difficulties.

[1] It would be somewhat less absurd if, at this point, we could relax the assumption of zero transport costs; then only those 'static' commodities would be traded whose transport costs were least per unit of value f.o.b.

F. The Generation of Innovations

Our model, as expounded up to here, started from a state of rest, and, in so far as two-way dynamic trade was generated, merely assumed that by chance country One innovated in the ith industry and country Two in the jth where i and j were randomly selected. We now have to make the model more properly dynamic by examining its working during a period of time when the process of innovation, dynamic trade, and, to some extent, induced trade have been proceeding for some time. We must investigate, that is, the mechanism of 'dynamic economies of scale' as defined in Section C. Whereas, from a state of rest, the choice of i and j could have no connexion with a previous history of successful innovation (because no such history had taken place), we must now ask whether there is some relationship between today's innovations and those adopted in the past: we must examine the possibility that the same industry is responsible for successive innovations. We will describe how this serial correlation may arise, and attempt to relate the discussion to the analysis of the different sorts of technical progress.

If we were discussing a closed economy we should certainly not expect, *a priori*, the stream of innovations during any particular period to be distributed randomly between industries. There are four reasons for expecting innovations to be concentrated in one industry or group of industries:

1. There may be a technical connexion between one innovation and its successor. A 'break-through' on one front will bring, quite rapidly, associated successes. Thus there will occur 'clusters' of innovations. It is impossible to assess, *a priori*, whether this effect will produce concentration of dynamism within one industry, or whether, in fact, by a converse effect, the benefits of the original discovery might provoke successors in quite different industries. The associated development of fast engines, speed resistant tyres, and disk brakes (all, broadly, in the automobile industry), is an example of clustering; the development of pressure die-casting is an example of the converse. But whichever effect predominates, the existence of some such technical correlation is very unlikely to result in an unbiased distribution of innovations between industries.[1]

2. There may be a similar connexion on the demand side—complementarities in consumption may lead to pressure for innovations in products jointly demanded with that just innovated.

3. It may so happen that one industry, in a particular period, is

[1] It may be that the existence of correlation will not only redistribute the incidence of innovations, but also increase the *number* of innovations.

blessed with an excessive quota of innovating entrepreneurs or research staff.[1]

4. There may be dissimilarities between industries in their expenditure on 'innovation-generating' research; i.e. the rate of investment may differ between industries.

It is technical 'clustering' which is nearest to the pure concept of dynamic economies of scale (as defined on p. 329 above), accruing to a firm by virtue of its past experience (or, more precisely, the aggregate of its output in the recent past). This is a generation of 'know-how' (specific to a firm) rather than of pure knowledge (freely available to all). Before an innovation appears on the market, embodied, so to speak, in a product, there is no doubt a gestation period whose duration may be quite considerable. If the gestation period is large, however small the foreigners' imitation lag may be, they may stay behind for a long time in the innovation race. This is so because, in the *absence* of technical correlation, the innovations within an industry would be randomly distributed through time; and a country which innovates at time t derives no advantage from 'knowing about' this innovation at $(t-g)$ (where g is the gestation period): the knowledge has no implications and cannot help in future development projects. But to the extent that correlation *does* occur, such foreknowledge can give the original innovator a head start which he need never surrender until the cluster of related innovations comes to an end. By the time the end comes, the unfortunate foreign competitor may have given up the ghost, unless his financial resources and optimism are considerable, or unless he *invests* sufficiently (and sufficiently quickly) in research to buy back the opponent's original lead. Conversely, extra investment by the original innovator can help to consolidate and extend his advantage. Eventually, even in this case, therefore, special patterns of investment behaviour may be crucial.

Even randomly generated innovations may lead to such stable configurations of trade, however, if we allow sufficiently for the effect of a once-for-all gain in generating optimism and investment. Suppose that the precise duration of a comparative advantage is, at some stages in the history of industries and nations, of crucial importance—'. . . there is a tide in the affairs of men . . .': then the slight extra time given, for example, by a chance provision of innovating skill, can sometimes be decisive in prolonging the advantage until some other effect takes over. This 'other effect' is provided by investment. A temporary advantage in one industry

[1] It must be assumed that these skills receive no reward (or rent) or at least inadequate reward; i.e. we assume some imperfection in the system of pricing factors of production. This sort of imperfection, however, is such a common phenomenon that it would seem absurd to rule it out altogether (although the general argument would not suffer from so doing).

can be extended if it lasts sufficiently long to attract extra investment expenditure: the importance of a first innovation, on this argument, is that it can lead to a clustering of investment, and that such investment can increase the rate of progress in this industry, leading in turn to an eventual further clustering of innovations; the effect is cumulative. Comparative advantage, on these assumptions, is caused, not by differences in relative factor endowment at a point of time, but by differences in the distribution of investment between industries.[1]

Some comments on investment behaviour are clearly necessary to our analysis at this point. We have assumed that overall savings ratios are initially identical in the two countries. The distribution of a given volume of investment will depend on the distribution of (subjective) 'animal spirits'; of (objective) possibilities of profit, growth, &c.; of the availability of finance; and of managerial 'growth potential'. Any of these may be the strongest influence at a point of time; and the objective profitability (or growth-generating) criterion can be of slight importance over relatively long periods. But eventually, in virtually all possible theories,[2] a reckoning of accounts with reality must be made; unless the 'unjustified' element of investment eventually forces an industry forward into a period of self-generating growth (auto-correlated innovations), the animal spirits will evaporate or migrate elsewhere.

We might be tempted to conclude, therefore, that a sufficiently stubborn streak of animal spirits will often lead to a 'take-off' for a particular industry at the expense of its foreign competitors; the critical question would be the speed at which technology could be urged forward (by investment) along particular lines. But such suggestions depend on too many empirical assumptions (e.g. do innovations affect whole 'industries'?; can investment in one sector accelerate the supply of technical innovations whose origin may be elsewhere?; &c.) to be properly made in a speculative paper.

To summarize this section we might ask whether, in light of the assumptions made, we would expect comparative advantage in particular industries or products to be stable or unstable.

1. Dynamic economies (technical or other clustering) lead to stability.
2. Random innovations, interacting with investment activity, might also lead to stability.
3. But a persistent advantage will often apply to *products* rather than to industries.

[1] A country which has once taken the lead in many industries simultaneously and therefore has a large surplus on current account will be in a better position to invest more rapidly all round and thus increase her advantage cumulatively. But this is outside our terms of reference.

[2] If we allow for monopoly, of course, the problem becomes more complex.

4. In any case, pure technical progress—the fruits of which are open to all—may lead to the abrupt overthrow of established positions.[1]

G. Conclusions

The model outlined in this paper is, I suggest, peculiarly appropriate to the explanation of trade which consists in the international exchange of different products of closely similar industries—e.g. machine tools. Such trade is not properly examined by an Ohlin-type model, because each national industry clearly uses the same factors in the same proportions;[2] nor is it an example of a once-for-all specificity of knowledge (since such trade can continue through time); nor, finally, should it necessarily be regarded as the result merely of static economies of scale, because (*a*) the precise pattern of trade is often changing, and (*b*) it may not be true (as a matter of fact) that the relevant economies could not be exhausted in a purely autarchic situation.

This dynamic model relies heavily on the validity of the analytical distinction between new and old processes or products, and on the assumption that economic change can not usefully be analysed as a series of marginal adjustments to an extant equilibrium. As authority for this view it is, of course, obligatory to cite Schumpeter, but I would diffidently suggest that doctrinal disputes between Schumpeterian and Marshallian approaches to these problems succeed in showing merely that each has its own merits and demerits. It is impossible to deny that my very simple dynamic model could be expressed as a special case of Ohlin-type trade; the justification for regarding it as *sui generis* cannot be advanced on analytical grounds alone, but must await an empirical study.

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[1] It would clearly be interesting to attempt an empirical investigation of these possibilities, and some such work is being attempted. A partial test of the whole model, for example, would be to measure the extent to which new products are imported during the imitation lag, and then replaced by home-produced substitutes. But this measure would be irrelevant to the case in which dynamic economies of scale had completely displaced an import-competing industry.

[2] However, differences in dynamism may lead to differences in rates of investment, and hence, eventually, to Ohlin-type differences in capital per head. But such a difference in endowments would arise as part of a dynamic process, and not as the *fons et origo* of trade.

AGRICULTURAL PRODUCTION, LOCATION, AND RENT[1]

By MICHAEL CHISHOLM

WRITING in 1951, Schultz[2] drew attention to the declining relative significance of agricultural land in advanced communities such as the United States of America, France, and Great Britain. He adduced evidence to show that agricultural land rent is a declining share of national income, primarily on account of the relative growth of non-agricultural occupations, but that even within agriculture changes in the aggregate production-function have tended towards the substitution of non-land for land inputs. The point was taken up by Price,[3] who collected evidence to show that changes in the aggregate production-function giving rise to a diminished importance of land have arisen from two causes:

(i) The general intensification of production in all types of enterprise, such that larger quantities of inputs such as fertilizers and capital equipment are now being applied to substantially the same area of land.

(ii) Changes in the structure of the industry, towards items the production of which requires relatively smaller inputs of land, e.g. the relative increase in horticultural production.

The present paper falls into two parts. In the first section it is shown that there is another important factor diminishing the relative significance of agricultural land, namely a decline in location rents. In the second part, the findings of Schultz and Price are tested against some evidence pertaining to the importance of agricultural land in different regions within a selection of countries.

Location Rents

If we take the United Kingdom as an example, a brief survey of changes in the location of agricultural production over the last century and a half leads to an important and obvious conclusion. With improvements in transport and the associated development of techniques such as refrigeration, many products once closely tied to the market have been

[1] Much of the work for this article was done at the Institute for Research in Agricultural Economics, Oxford, and I am indebted to the staff thereof for a considerable amount of help, including assistance with computations.

[2] T. W. Schultz, 'The Declining Economic Importance of Agricultural Land', *Economic Journal*, 1951, pp. 725–40.

[3] O. T. W. Price, 'The Economic Significance of Land as a Factor of Production, with Particular Reference to Agricultural Land', *Farm Economist*, vol. vii, no. 6, 1953, pp. 239–53.

produced at successively greater removes therefrom. Liquid milk is one of the most striking cases, being now consigned from Cornwall and Pembrokeshire as far as London and Birmingham, whereas formerly all milk for liquid use was produced in the immediate environs of the consuming centres. Currently, milk and milk products account for about one-quarter of the gross revenue of those farms which are included in the Farm Management Survey. A similar phenomenon is to be noticed in the case of horticultural products, with the marked increase in relative importance of the Fens and the south-west.

But perhaps even more striking has been the enormous increase in imports of meat, butter, cheese, and grains, which now come literally from the ends of the earth.

Part of the explanation for these changes lies in the increase of population, which has outrun our ability to provide sustenance. But it is surely just to infer that these locational shifts imply a diminution in the relative significance of location with respect to the market, consequent upon a cheapening of relative transport costs.[1]

The extent to which transport costs have become proportionately lower is difficult to establish in precise detail, though there is ample testimony that there was a spectacular decline during the nineteenth century.[2] Whether the trend has been maintained during this century in advanced countries such as the United Kingdom is a moot point; I incline to the view that it has. However, there can be no doubt that in the less advanced economies there is today a steady reduction in relative transport costs, arising from the substitution of modern for primitive means.

Table I gives an indication of the decline in 'real' ocean freights during the last century, providing one measure of the relative decline in transport costs.

If certain simplifying assumptions are made, many of which will be later relaxed, it is possible to analyse the effects of a decline in transport costs upon the relative importance of rent. In so doing, the analysis follows very closely that developed by von Thünen,[3] by introducing into his method

[1] The point was noticed by O. E. Baker, 'The Increasing Importance of the Physical Conditions in Determining the Utilization of Land for Agricultural and Forest Products in the United States', *Annals*, Association of American Geographers, 1921, pp. 17–46.

[2] The matter was well documented by A. de Foville, *La Transformation des moyens de transport et ses conséquences économiques et sociales*, Paris, 1880.

[3] H. von Thünen, *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*, 1826. Currently available in German is an abridged text, *Johann Heinrich von Thünen: ausgewählte Texte*, edited by W. Braeuer, 1951. A good summary is contained in *Économie et espace*, C. Ponsard, 1955. For partial accounts and elaborations in English, see R. Krymowski, 'Graphical Presentation of Thuenen's Theory of Intensity', *Journal of Farm Economics*, 1928, pp. 461–82; E. T. Benedict, *Theodor Brinkmann's Economics of the Farm Business*, 1935 (translation); R. Cohen, *The Economics of Agriculture*, 1940 (reprinted to 1957); A. Lösch, *The Economics of Location*, 1954 (translation); E. S. Dunn, Jr., *The Location of Agricultural Production*, 1954.

TABLE I*

'Real' Ocean Freights, 1876–1913 (1913 = 100)

Index of Freights divided by Index of Commodity Prices

Year	*'Real' freights*	*Year*	*'Real' freights*
1876–80	172	1896–1900	113
1881–5	151	1901–5	92
1886–90	137	1906–10	81
1891–5	113	1911–13	101
		1913	100

* *Sources*: Index of freight rates from C. P. Kindleberger, 'Industrial Europe's Terms of Trade on Current Account, 1870–1953', *Economic Journal*, 1955, p. 23: index of prices of commodities entering international trade prepared by Mr. D. T. Healey, Institute of Commonwealth Studies, Oxford.

the idea of changes in freight-rates. In his analysis of location, von Thünen was concerned with the economic rent arising from different enterprises at different locations, treating rent in the Ricardian manner as a surplus. Whereas Ricardo took rent to accrue to lands differing in quality with respect to inherent productive capacity, von Thünen argued the case in which quality varied on account of location: economic rent then arises from variations in the incidence of transport costs on both inputs and the output.[1]

Fig. 1 has been constructed on the following assumptions:

1. *O* represents a single market for agricultural produce.
2. *OEFG* represents a section across all locations at increasing distances from *O*.
3. *OBLCD* represents the level of prices or costs.
4. Only one crop is being grown, say wheat.
5. All the land is occupied by this crop.
6. The yield per acre is constant at all locations.
7. *OB* represents the costs of production of wheat, including labour income.
8. *BH* represents the cost of transporting an acre's production from any point to the market at *O*. All points are equally accessible.

Under these circumstances, the price received for a ton of wheat at *O* is *OD*, and no production will take place beyond *E*, because the cost of transport would render cultivation unprofitable. The surplus which is available

[1] von Thünen was aware of Ricardo's work, and explicitly recognized the similarity of viewpoint. He claimed, rightly, that Ricardo's is only a partial explanation of economic rent. In view of this, it is strange how von Thünen has been neglected in the development of the theory of rent. Incidentally, in teaching the concept of rent, the von Thünen approach lends itself to diagrammatic treatment, and is readily grasped by students as a first step.

as economic rent is shown by the triangle *BDH*. Actually, as this is only a transect across locations in one direction from *O*, the total amount of

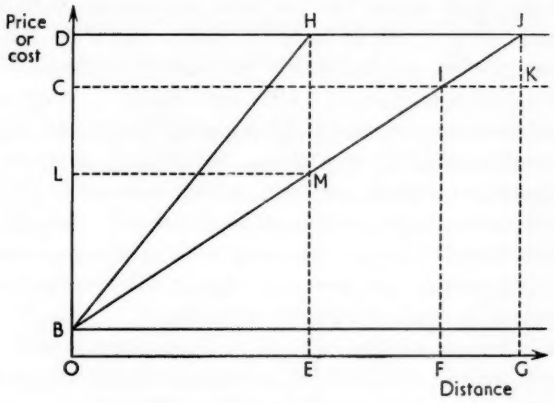

FIG. 1

economic rent is obtained by rotating *BDH* about the axis *BD*, to form an inverted cone. Hence the total amount of economic rent is given as:

$$\tfrac{1}{3}\pi(OE)^2BD. \tag{1}$$

In the same situation, total production costs are given by

$$\pi(OE)^2OB. \tag{2}$$

And the total value of production is

$$\pi(OE)^2OD. \tag{3}$$

Let us now take a second situation, in which transport costs have fallen from *BH* to *BMIJ*. If, under these new conditions, yields and production costs remain the same, and demand does not rise at all in response to a lower price, then the market price will fall to *OL*, and total output will remain constant. Hence we have:

$$\text{Total economic rent} = \tfrac{1}{3}\pi(OE)^2BL \tag{1a}$$

$$\text{Total production costs} = \pi(OE)^2OB \tag{2a}$$

$$\text{Total value of production} = \pi(OE)^2OL \tag{3a}$$

Production costs remain constant, total value of production has fallen in the ratio of *OD*:*OL*, and total economic rent has fallen in the ratio of *BD*:*BL*. Necessarily, the decline in economic rent is proportionately

greater than the decline in value of production, and hence economic rent is now relatively less important than formerly.

It will be objected that in practice the level of production costs will tend to fall, and that in so far as this does occur the relative decline in importance of economic rent will be lessened, and indeed that if costs fall far enough economic rent could actually increase in significance. Whether this would actually happen turns on the distribution of the benefits between landowners on the one hand (economic rent) and consumers on the other (market price). In practice, a decline in production costs, with transport charges remaining constant at their new levels, and the total quantity demanded being stable, would mean that at the margin of cultivation there would still be some economic rent accruing to land. Such a situation is implausible, and we may expect a decline in market price exactly equal to the diminished costs of production.

In this case the ratio of total value of production becomes $OD:(OL-X)$, and total rent becomes $BD:(BL+X)$. It is inherently very unlikely that the decline in production costs, X, would be sufficiently large to offset the diminished relative importance of economic rent, for the following reasons. Production costs amount to roughly 80 per cent. of the revenue realized by farmers in this country. Hence, if we imagine, according to our previous analysis, a decline in transport costs of 50 per cent., everything else remaining unchanged in the first instance, we may expect the total amount of economic rent to be halved ($BL = LD$). At the same time, the total value of production would decline by roughly 10 per cent. ($OB = 4BD$), and production costs remain constant. For rent to remain a constant portion of production costs, these latter would have to decline by 5·5 per cent.[1] For this to occur, transport costs would have to amount to 11 per cent. of the cost of all inputs in the initial situation, and it is highly unlikely that this should be so. Labour in particular is likely to be hardly affected, while the transport element in many other inputs is certainly well below 11 per cent.

Hence this objection cannot be sustained, and we may turn our attention to the more realistic position in which there is some price elasticity of demand. Returning, then, to Fig. 1, we may envisage the new equilibrium price as CIK, production costs, OB, remaining constant and transport

[1] To obtain the orders of magnitude involved, the following calculation has been made. Let production costs equal 8, and the price at market O equal 8+2. Then, according to our previous analysis, economic rent equals 1. If transport costs are halved, economic rent will decline to $\frac{1}{2}$ in the first instance. For economic rent to remain the same proportion of production costs, the following relationship must be satisfied:

$$\frac{1}{8} = \frac{\frac{1}{2}+X}{8-X}.$$

Hence $X = 0{\cdot}444$, which equals 5·5 per cent. of 8.

charges represented by *BMIJ*. The new totals of economic rent, production costs, and value of production are given below:

$$\text{Total economic rent} = \tfrac{1}{3}\pi(OF)^2BC \qquad (1\,b)$$

$$\text{Total production costs} = \pi(OF)^2OB \qquad (2\,b)$$

$$\text{Total value of production} = \pi(OF)^2OC \qquad (3\,b)$$

Compare these expressions with (1), (2), and (3) above, and it will be observed that, whereas total production costs have increased in proportion to the cultivated area, the total value of production has increased less, to the extent that *OC* is less than *OD*, while economic rent has risen by an even lesser quantity because *BC* is a smaller proportion of *BD* than is *OC* of *OD*. Hence economic rent has declined in relative importance.

It were wearisome to repeat the argument concerning a probable diminution of production costs, for the conclusion is the same as previously, even when allowance is made for a further increase in cultivated area consequent upon a diminution in the market price *CIK*.

Our discussion remains unreal in several respects, and the task of the next succeeding paragraphs is to take up some of the unrealities and show that in fact they do not disturb the argument which has been advanced.

We have assumed that only one crop is grown, that it occupies all the land, that yields are uniform, and that production costs are constant in space. In practice, the spatial level of rent results from the competition of various possible uses and between numerous entrepreneurs willing to enter the agricultural business. If we imagine the level of economic rent at any point resulting from the interplay of these considerations, with a zoning of production about the market, then a reduction in transport costs will influence the relative importance of economic rent for all products in the manner which has been developed.

The yield of any one crop, and production costs thereof, are not constant in space, and substitution between enterprises and types of input does occur from one location to another in the attempt made by entrepreneurs to maximize their returns. There is no evident reason why this should do more than complicate the analysis, without affecting the principle at issue.

Implicit in the argument detailed above is the assumption that in all circumstances there is additional land which can be brought into use or included for the first time in an exchange economy, as a result of reduced transport costs. This seems to be an entirely reasonable assumption, as many parts of the world remain unexploited. But the increments are commonly stepped rather than continuous, owing to the unequal distribution of cultivable land and barriers to communications.

And we have imagined a single market, analogous to von Thünen's *Isolated State*. This is clearly unreal, in that 'the market' is composed of

a multitude of points, as many as there are consuming households. But it depends entirely upon the scale of consideration. In present-day Britain, it would be vain to attempt to differentiate the influence of London and Birmingham on agricultural location within this country, for there is a multitude of overlapping spheres of influence. But if we take the United Kingdom as a whole, 'the market' is concentrated in a belt roughly bounded by London, Southampton, Leeds, and Liverpool. For example, it is within or closely adjacent to this region that the bulk of horticultural production in England and Wales occurs, except for that located by the advantages of climate in the south-west. In the milk industry, the Milk Marketing Board is attempting to rationalize affairs by encouraging what manufacturing of milk there is to locate in the remoter areas, such as Pembrokeshire. There is thus some degree of zoning about this concentration of population.

This becomes even more apparent when we consider this country in relation to its imports from the rest of the world, for then we may truly regard the United Kingdom as a single market.[1]

The foregoing analysis has served to demonstrate that, with a decline in transport costs, the aggregate economic rent within the agricultural economy declines in relative importance. But that does not mean that there will be a diminution at all points in the system, and indeed it is easy to show that the overall diminution may well be merely a net result, compounded of some increase and some decrease. Referring to Fig. 1, imagine that transport costs fall from BH to $BMIJ$, and that simultaneously the market price tumbles from DHJ to LM. At all points between O and E, therefore, the market price has fallen by DL, but the absolute fall in transport costs varies from nothing at O to HM ($= DL$) at point E. In terms of both production costs (OB) and market price, economic rent has varied not at all at point E (none being payable), while at point O there has been a substantial drop in the absolute and relative amount.

At the other extreme, imagine that, despite a cheapening of transport, the market price remains constant at DHJ. In this case, the cultivated area will extend to G, and at all points other than O and G there will be a rise in the relative importance of rent. Between O and E this increase is measured by the difference in height between BH and BM, which is increasing with distance from O: beyond E the increase has been proportionately infinitely large, being the ratio of a positive number to zero. But at point G economic rent disappears. This increase in the importance of rent at all points between O and G is compatible with an overall decline, because the *proportions* of land bearing different relative levels of rent have changed.

[1] This argument is to be expanded and documented in a forthcoming book, *Rural Settlement and Land Use: an Essay in Location*, to be published by Hutchinson.

An intermediate case, which is the likely situation, is represented by a fall in market price to the level of *CIK*, with the cultivated area being extended to *F*. Clearly, in the sector between *E* and *F*, there has been an increase in the relative importance of economic rent, for there was formerly none. Yet at *O* economic rent has declined in relative importance.[1] There is a point intermediate between *O* and *E* at which economic rent will remain a constant portion of market price, and another point (possibly the same) at which it remains stable in relation to production costs. These points will be determined by the slopes of the lines and the relative values on the vertical scale, and therefore are only determinate in specific cases.

Hence, it is entirely probable that a reduction in transport costs will result in some areas experiencing a decline in the relative importance of economic rent, while in other regions the reverse occurs: and the former will be situated near the consuming centre, while the latter are in the peripheral regions.

At this point we may return from the exposition of theory to the case of Great Britain at the end of the last century. The agricultural depression had its root cause in a remarkable diminution of transport costs relative to the value of commodities. If we regard this country as a single market, but a point on the earth's surface, then the real transport costs involved in bringing in foodstuffs fell during the last century for two principal reasons: (1) improved ocean vessels and terminal facilities; and (2) the construction of railways in previously virgin or sparsely settled territory, substituting a much cheaper mode of movement. Towards the end of the century there was the equally important application of refrigeration to the transport of perishable commodities.

It was these transport developments which made possible a very rapid rise in the level of imports of agricultural produce, in direct or indirect competition with home production. Admittedly, other important factors had a part to play, such as the spread of settlement in the plains of the United States and elsewhere, and the elaboration of agricultural machinery, wind pumps, and the like. But the transport improvement was the fundamental factor.

Hence arose the crisis conditions which prompted the establishment of a Royal Commission whose Final Report was published in 1897,[2] wherein is a wealth of detail. The Commissioners singled out as the fundamental cause of depression the rapid increase in food and wool imports, sufficient to depress prices generally by between one quarter and one half in the period

[1] *CD*/*BD* is greater than *CD*/*OD*, and hence economic rent declines more rapidly than market price. Costs of production, *OB*, remain constant.

[2] 'Final Report of Her Majesty's Commissioners appointed to inquire into the subject of Agricultural Depression', Parliamentary Papers, 1897, vol. xv (1).

1876–8 to 1893–5. With prices tumbling, rents and land values also suffered severely.

TABLE II

United Kingdom: Prices of Agricultural Products, 1876–8 and 1893–5
(1876–8 = 100)

Commodity	*Relative price in 1893–5*
Wheat	48
Barley	63
Oats	66
Cattle, inferior quality	60
second quality	73
first quality	76
Sheep, inferior quality	69
second quality	79
first quality	83
Pork, bacon, hams	90
Wool, average of three North Country types	50

Source: Royal Commission, 1897, part ii, chapter ii.

The behaviour of prices was not the same for all commodities, and hence different regions had different fortunes. The Commission observed that generally it was the arable areas which were the worst hit, consequent upon the relatively great rise in wheat and wool imports—sheep forming an integral part of many arable rotations. These were the major non-perishable goods which stood to gain most from a cheapening of transport (without any other concomitant developments). Only towards the end of the century did refrigeration really enable the mass import of fresh meats and dairy produce from great distances.

In the words of the Commission: 'In districts suitable for dairying, market gardening, and poultry rearing, and in the neighbourhood of mines, quarries, large manufacturing centres, and towns, where there is a considerable demand for farm produce, there has been relatively less depression.'[1] That is to say, where distance still conferred substantial protection for perishable goods, adversity was much less marked.

Thus the general situation in this country at that time fundamentally arose from changes in relative locational advantages with improved transport; and hence, too, are explained many of the regional differences observed within our shores. We should expect to find a substantial decline in the relative importance of economic rent during the last three decades of the nineteenth century, on account of diminished location rent if for no other reason. Bellerby has obtained figures which, while not *proving* the

[1] Royal Commission, loc. cit., para. 72.

point, are consistent with it and highly suggestive. In this case, rent represents the actual or imputed payment for the use of land and fixed equipment, and is not strictly equivalent to economic rent. The rising rental proportion in the earlier periods may be attributed to the lag between farm income changes and adjustments in rental payments.

TABLE III[1]

United Kingdom: Agricultural Factor Income and Rent, 1867–73 to 1936–8

Annual average	*Total factor income of agriculture*	*Rent*	
All Ireland included	£m.	£m.	%
1867–73 . . .	146·1	34·2	23
1874–8 . . .	143·1	35·6	25
1879–83 . . .	115·3	32·6	28
1884–96 . . .	109·8	25·0	23
1897–1910 . .	112·3	20·8	19
1911–14 . . .	132·9	22·6	17
Eire excluded			
1923–9 . . .	167·1	24·9	15
1930–2 . . .	152·9	25·1	16
1933–5 . . .	166·5	23·8	14
1936–8 . . .	173·0	24·9	14

Before the turn of the century the biggest single supplier of agricultural imports was the United States, and it is instructive to examine developments in that country during this period of depression in British agriculture. With the opening up of the prairie lands west of the Appalachian Mountains, consequent upon canal and railway construction, the Atlantic States found that competition from the interior tended to depress certain types of agriculture, notably grain growing, but also livestock: there was an actual decline in wheat acreage in some eastern States. This was in part due to the much larger size of farm in the west, where conditions were also more suitable for mechanization, with the consequence that production costs there were markedly lower. But up to the First World War the eastern States certainly did not suffer on the scale that British agriculture did, and the interior and west were enjoying boom conditions, with land values rising rapidly. This can be seen from Table IV, which shows changes in the *value* of farmland as assessed at the decennial censuses.

[1] J. R. Bellerby, 'Distribution of Farm Income in the United Kingdom 1867–1938', *Journal*, Agricultural Economics Society, 1953, p. 130.

TABLE IV

United States: Average Value per Acre of Farm Land plus Buildings, 1850–1910 (1850 = 100)

Geographical divisions	*1850*	*1860*	*1870*	*1880*	*1890*	*1900*	*1910*
New England	100 ($20.27)	117	118	133	122	127	180
Middle Atlantic	100 ($29·42)	137	162	163	162	148	192
West South Central	100 ($5.64)	154	72	95	140	114	328
East South Central	100 ($6.35)	196	129	139	165	181	336
Mountain	100 ($5·83)	48	88	251	231	125	380
South Atlantic	100 ($6.17)	154	110	143	184	188	388
East North Central	100 ($13.38)	179	226	256	290	316	562
West North Central	100 ($6.40)	175	243	232	308	362	780
Pacific	100 ($1.55)	383	747	967	1,779	1,301	3,115
United States	100 ($11.14)	147	164	171	191	178	356

Source: Fifteenth Census of the United States, 1930. Agriculture, vol. iv, General Report, p. 74.

Without doubt, therefore, the theory of location and location rents contributes to our understanding of changes in the relative importance of rent for agricultural land.

Regional Differences in the Significance of Land

The analysis developed by Price suggests that at any one time there ought to be substantial regional differences in the relative importance of land within any one country. Such variations should arise from differences in the level of technical advancement, such that combinations of factor inputs vary from place to place. They should also occur in response to variable combinations of enterprise types, those with high and low land requirements tending to be concentrated in certain areas. And location rent also is distributed unequally in space. In this section evidence will be presented to show that indeed there are distinct regional variations in the relative importance of land, and that these variations are remarkably constant. The consistency with which the significance of land differs from one part of a country to another is sufficient to prompt the argument that in fact these variations do not arise principally from differences in the combinations of enterprise types, as might at first be thought. Rather, it will be shown that the most important consideration is that the net influence operating on *all* types of agriculture in any one area must be roughly the same. In other words, that regional differences within a type of agriculture are as great, or nearly as great, as the contrast in average situation between regions.

There are numerous other reasons why the importance of land should

vary regionally, but for the most part they either operate through the type and intensity of farming, or, if independent factors, appear to exert but a small influence which may safely be ignored in the present context.

Table V displays data for five countries, being those for which the

TABLE V*

The Relationship between Annual Gross Output and Capital Land Value or Annual Rent, Current Money Values per Unit Area

Year	*Regression*	R^2	*Meaning of* X *and* Y
United States			
1910	$Y = -3{\cdot}2+4{\cdot}1\,X$	0·70	Y = value of farm land plus buildings, U.S. $ per acre
1920	$Y = 6{\cdot}7+2{\cdot}4\,X$	0·49	
1930	$Y = 6{\cdot}3+3{\cdot}7\,X$	0·81	
1940	$Y = 10{\cdot}3+2{\cdot}9\,X$	0·89	X = value of gross sales, U.S. $ per acre
1945	$Y = 12{\cdot}7+1{\cdot}9\,X$	0·79	
1950	$Y = 23{\cdot}8+2{\cdot}0\,X$	0·85	
1954	$Y = 26{\cdot}2+2{\cdot}6\,X$	0·86	
Brazil			
1950	$Y = 64{\cdot}8+2{\cdot}4\,X$	0·91	Y = value of farm land plus buildings, Cr. $ per hectare X = value of gross production, Cr. $ per hectare
Philippines			
1948	$Y = -97{\cdot}8+2{\cdot}7\,X$	0·54	Y = value of farm land plus buildings, 1,000 pesos per hectare X = value of gross production, 1,000 pesos per hectare
Italy			
1956–7	$Y = 0{\cdot}577+0{\cdot}186\,X$	0·70	Y = Rent of farm land plus forest land, 1,000 lire per hectare X = value of gross sales of farm land plus forest land, 1,000 lire per hectare
England and Wales			
1952–3	$Y = 35{\cdot}9+0{\cdot}037\,X$	0·71	Y = value of farm rent plus rates, £ per 100 acres
1953–4	$Y = 39{\cdot}6+0{\cdot}035\,X$	0·67	
1954–5	$Y = 54{\cdot}0+0{\cdot}034\,X$	0·63	
1955–6	$Y = 44{\cdot}4+0{\cdot}037\,X$	0·68	X = value of farm gross revenue plus net valuation change, £ per 100 acres
1956–7	$Y = 40{\cdot}1+0{\cdot}036\,X$	0·58	
1957–8	$Y = 50{\cdot}1+0{\cdot}037\,X$	0·52	

* *Sources and methods:*

U.S.A. Decennial censuses of agriculture. The tables do not always refer to the same acreage and number of farms, and some estimation is necessary to obtain comparability: this was done by inflating by the number of farms where necessary.

Brazil. Census of agriculture as published in *Annuário Estatistico do Brazil*, 1958. Figures for livestock products were obtained from the Conselho Nacional de Estatistica, Rio de Janeiro. Figures for meat, meat extracts, and hides relate to packing stations' output, and were deflated by 20 per cent. to give an ex-farm valuation.

Philippines. Philippine Agricultural Statistics, vol. ii, 1954. Figures relate to the total area in farms, and include only the value of production of crops.

Italy. Annuario dell' Agricoltura Italiana, 1957, and *Annuario Statistico Italiano*, 1956, supplemented by data from the Istituto Nazionale di Economia Agraria, Rome. The rental data available relate only to rented holdings, and it has been assumed that each provincial average may be applied to all farms in that province.

England and Wales. Farm Incomes in England and Wales, Ministry of Agriculture, Fisheries, and Food, various years.

relevant material was available to me. The regressions of rent or land value on gross revenue have been obtained by using average figures for states or provinces, except in the case of England and Wales. In this country, cost accounts are kept for a sample of 2,172 farms, which are divided into forty-two types of farming categories (specialists excluded) which broadly speaking represent homogeneous farming regions.

It will be observed that the more intensive the farming is, as measured by gross revenue a unit area, the lower is the significance of land, which thus far tends to confirm the findings of Price. This can be seen more readily from Table VI, wherein are shown the extreme observed values of X (gross

TABLE VI*

Year	*Extreme values of* X *(gross revenue per unit acre)*		*Calculated value of* Y *(land value or rent per unit area at extremes of* X*)*		*Rent or value*	*Rent or value as multiple of product*	
	Min.	*Max.*	*Min.*	*Max.*		*Min.* X	*Max.* X
United States							
1910	2·2	24·4	5·8	96·8	value	2·6	4·0
1920	3·1	59·1	14·1	148·5	,,	4·5	2·5
1930	2·0	50·5	13·7	193·2	,,	6·9	3·8
1940	1·3	44·6	14·1	139·6	,,	10·8	3·1
1945	1·7	92·4	15·9	188·3	,,	9·4	2·0
1950	3·7	131·4	31·2	286·6	,,	8·4	2·2
1954	3·1	145·4	34·3	404·2	,,	11·1	2·8
Brazil							
1950	5·0	877·0†	76·8	2,169·8	,,	15·4	2·5
Philippines							
1948	49·0	499·8	34·5	1,251·7	,,	0·7	2·5
Italy							
1956–7	36·8	191·7	7·4	36·2	rent	0·20	0·19
England and Wales							
1952–3	541	6,826	56	289	,,	0·10	0·04
1953–4	541	7,575	59	305	,,	0·11	0·04
1954–5	481	7,495	70	309	,,	0·15	0·04
1955–6	470	7,839	62	334	,,	0·13	0·04
1956–7	521	8,518	59	347	,,	0·11	0·04
1957–8	629	8,881	73	379	,,	0·12	0·04

* Units as in Table V. Source, Table V.

† In the case of Brazil, the Federal District has an even higher average product (Cr. $ 5,497 per hectare), but this is a small and highly unusual area; therefore the State with the next highest output per hectare has been chosen.

revenue per unit area) and the expected values of Y (rent or land value) obtained from the equations in Table V. The United States in 1910 and the Philippines in 1948 are the two exceptions to the general rule, with land becoming progressively more important at the higher levels of production.

The situation in the Philippines may be explained by the immobility of the population, which results in great disparities between the over- and under-populated areas. In the former, competition for what little land there is forces up values to an extent which is disproportionate to the value of production.[1] The same position obtained in Egypt in 1950, according to figures prepared by Mr. A. R. Meguid, former student at the Institute for Research in Agricultural Economics, Oxford.

TABLE VII*

Egypt: Rent as Percentage of Gross Product

Upper Egypt			*Lower Egypt*		
Province	*Rent as % of gross product*	*Active persons per feddan*	*Province*	*Rent as % of gross output*	*Active persons per feddan*
Fayoum	44·5	1·1	Behera	34	1·0
Menir	47	1·4	Dakahlia	35	1·3
Assiut	47·5	1·5	Gharbia	35·5	1·2
Beni-Suef	50	1·6	Kaliubia	36·5	1·6
Asswan	50	1·7	Menoufia	40	1·9
Kena	52·5	1·7			
Guiza	52·5	1·9			
Guerga	54	2·2			

* The figures have been read from a diagram.

For the anomalous situation in the United States in 1910 there is no explanation which is evident to me.

The generally high degree of association found between the variables prompts the question whether the correlations are spurious in the sense that the data for one variable have been wholly or partly derived from data for the other. Examination of the material shows that this is not the case. In the censuses of the United States, Brazil, and Philippines, farmers were asked to record the value of their properties and the quantities of specified crop products, to which a price has been given subsequently. In the United States, animal products were recorded by value, but in Brazil other sources of information had to be tapped for these items (for example, returns of meat-packing stations), while for the Philippines nothing is

[1] The Philippine statistics contain errors and inconsistencies in the tabulation which cast some doubt on the veracity of the findings.

available on livestock production. Hence in all three cases the farmer was asked to return land value without having to know his total revenue, and therefore the former would not normally be derived from the latter. The Italian rent figures were obtained from a survey independent of the assessment of production. In this country the figures are obtained annually from carefully scrutinized accounts of a sample of farms, and hence the figures are arrived at independently. Thus, there can be no doubt that the associations shown in Table I are genuine, though this is not to imply that they are in any manner *causal* relationships.

The material which is available necessitates the use of both land value and rent; however, it is reasonable to assume that both are systematically and causally related to the capacity of the land (plus improvements) to yield a net income, and that therefore they are merely different measures of the same thing. Hence the argument is not impaired. More pertinent to observe is the control which has been exercised over agricultural rents in this country until the recent past. However, while these controls have undoubtedly depressed the general level of rents, there is no evidence to suggest that their impact has differentiated between areas, and hence regional differences in the relative importance of rent are not influenced.

For want of sufficient data, the argument thus far has been couched solely in terms of gross product, but it can be buttressed by material for Italy and England and Wales pertaining to production expenses and net income. For the same years as previously, straight-line regressions have been run of expenses on gross revenue and net income on gross revenue, yielding values of R^2 of not less than 0·53. (Expenses plus rent plus net income add to gross revenue.) From these regressions, Table VIII has been compiled, similar to Table VI. It is readily observed that rent declines as a proportion of working expenses as the intensity of production rises, thereby confirming the results obtained by using gross revenue.

At first sight, these findings appear to confirm the conclusions of Price, that substitution of production factors and enterprise types, working towards an intensification of farming, leads to a reduction in the relative importance of land. But closer examination shows that this is not so. Imagine for a moment that there are two regions, *A* and *B* (Table IX), each of 100 acres extent, and each occupied by three different types of enterprise. These types of enterprise have differing levels of gross revenue and rental payments per acre. By combining these three enterprises in different proportions it is quite possible to obtain the same total gross revenue but a different sum of rents, or vice versa, as is shown in this hypothetical case. Hence, there is no *a priori* reason to suppose that the relative importance of rent will vary regularly with differences in the intensity of production.

TABLE VIII*

Rent in Relation to Expenses

Year	*Extreme values of* X *(gross product per unit area)*		*Calculated rent per unit area at extremes of* X		*Calculated expenses per unit area at extremes of* X		*Rent as multiple of expenses at extremes of* X	
	Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*
Italy								
1956–7	36·8	191·7	7·4	36·2	7·8	44·5	0·95	0·81
England and Wales								
1952–3	541	6,826	56	289	329	5,275	0·17	0·055
1953–4	541	7,575	59	305	272	5,775	0·22	0·053
1954–5	481	7,495	70	309	209	6,059	0·33	0·051
1955–6	470	7,839	62	334	442	6,043	0·14	0·055
1956–7	521	8,518	59	347	210	6,871	0·28	0·051
1957–8	629	8,881	73	379	255	6,923	0·29	0·055

* Units as in Table I.

TABLE IX

Hypothetical Case of Variation in the Relative Importance of Rent, within a Region of 100 acres

	Area, acres	*Gross revenue* £	*Gross revenue* £ *per acre*	*Rent* £	*Rent* £ *per acre*
Region *A*	50	200	4	20	0·4
	30	300	10	40	1·33
	20	500	25	40	2·0
	100	1,000	10	100	1·0
Region *B*	25	100	4	10	0·4
	65	650	10	86·5	1·33
	10	250	25	20	2·0
	100	1,000	10	116·5	1·2

Analogous reasoning shows that where a new technique has been applied differentially, favouring some areas and not others, and conferring its greatest benefits to certain types of enterprise only, the significance of land will not necessarily bear a regular relation to the intensity of farming.

The high degrees of positive correlation which have been found therefore require some explanation. Either:

(i) Fortuitously, factor input and enterprise combinations do provide the basis.

(ii) The regional variations in intensity of land use within any one category of farming are as great, or nearly as great, between regions as are the average regional differences. Where the average intensity of farming is low the intensity for all types is low, and vice versa.

The second possible reason is more plausible and is supported by some evidence, albeit not conclusive. The recent survey of rented holdings in England and Wales, published by Denman and Stewart,[1] shows that there is some tendency for the rents paid by one type of enterprise to be high or low according as the rents of other kinds in the same county are elevated or depressed. However, the basic data are not entirely satisfactory, for each tenant was asked to classify his holding into the relevant type-of-farming category, and hence the classification is not based on uniform criteria. Correlations between the pairs of farming types yield very low positive associations.

More reliable is the finding of Kendall[2] that the average yield of any one crop in an English county is positively associated with the yield of other crops grown in the same county. This finding is based on correlations between all the possible pairs of ten crops, relating the yield per acre of one to the yield of the other. The crops are: wheat, barley, oats, beans, peas, potatoes, turnips and swedes, mangolds, hay from temporary grass and hay from permanent grass. The correlations were performed for 1925, 1930, 1935, and 1936, a selection of years designed to represent the range of climatic conditions commonly experienced. Even the hay crops showed quite reasonable correlations with the arable crops. Thus, Kendall concludes that, within the range of conditions found within England, an area yielding good crops of one product tends to yield good crops of others. But of course not necessarily in the same measure, else there would be no regional comparative advantages.

In so far as location rents do operate,[3] they also tend to a similarity of incidence on all types of farming within an area. If they did not, there would be substitution of enterprise types until an equilibrium was reached, those enterprises able to afford a higher location rent bidding land prices up. So this, too, is a factor operating towards a similarity of the net influence on all types of farming as regards the level of rent payable in any particular region.

[1] D. R. Denman, V. F. Stewart, *Farm Rents: a Comparison of Current and Past Farm Rents in England and Wales*, 1959.

[2] M. G. Kendall, 'The Geographical Distribution of Crop Productivity in England', *Journal of Royal Statistical Society*, 1939, pp. 21–48.

[3] In England and Wales roughly one-quarter of farm income in the Farm Management Survey sample is derived from milk and milk products. Yet the price structure under the Milk Marketing Board is such, notably with respect to transport costs, that locational advantages and disadvantages are averaged over all producers and consumers. Hence, *within* this country, no locational rent with respect to major markets exists for dairy producers.

And thus it is established that propositions which are true over time regarding the declining importance of agricultural rent do not have an automatic application to a cross-section in space at a given moment in time. Which is not to imply that Schultz and Price say the contrary, for they do not.

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THE NEW INDUSTRIES BETWEEN THE WARS

By H. W. RICHARDSON

FROM the vantage point of the sixties, the experience of the new industries[1] in the inter-war years would seem to suggest that in their progress could be discerned the basis of a new industrial future for Britain. Strangely enough, the orthodox view on the subject gives the opposite impression: it argues that the central fact about the new industries' development in this period was not that they were growing at a rapid rate, but rather that they were growing very slowly in relation to their position in other countries. More surprisingly, this judgement has been unanimous; scarcely anyone, overtly at least, has dissented from it. It is the purpose of this article to examine certain aspects in this judgement and to suggest that the expansion of the new industries between the wars was satisfactory, and consequently it is unnecessary to talk of Britain's declining entrepreneurship, her slowness to innovate, or failure to exploit export markets to the full to account for non-existent backwardness. It is believed that the attempt to decry the role of these industries is a misunderstanding to be explained partly by the fact that its protagonists have emphasized the wrong issues and made irrelevant comparisons, but largely because they have ignored (or did not have at their disposal) important evidence in recent books and articles which conflicts with their interpretation.

I

In volume iii of his famous work *An Economic History of Modern Britain*, Sir John Clapham drew attention to the slow growth (aluminium, electrical engineering) or absence (dyestuffs, pharmaceutical products) of new industries in Britain in the period 1887–1914.[2] Possibly here lay the seeds of the orthodox judgement discussed above. What happened was probably this: economists and historians came from reading Clapham to look at the new industries in the twenties and thirties and found ample evidence for a similar trend; without paying too much attention to the significance of the growth potential of the new industries revealed in their absolute increase in output, they merely extrapolated Clapham's argument referring to the period before 1914 into the inter-war years. Certainly, since the thirties economists have repeatedly put forward the view that the new industries' performance could have been better. The first expression of this judgement was probably A. Loveday in *Britain*

[1] By new industries, I refer not only to those industries which had their origins in this century such as the motor, wireless, and rayon industries, but also to those which were in existence in the last century but did not show any marked advance until this, such as the electrical, chemical, and rubber industries.

[2] Section III.

and World Trade (1931): 'Today what is really important and significant in England is not the depression of the depressed industries, but the relatively small progress made by the relatively prosperous' (p. 160). In the standard work *British Industries and their Organization* (1933), G. C. Allen took a similar standpoint, reasonable in the period of world depression, but what is surprising is that the same argument remains unmodified in the fourth edition of the book published in 1959; for example (p. 24): 'What is significant about the British position is that this country shared in an exaggerated degree in the depression which existed in some trades and failed to advance as much as the rest of the world in the industries which grew most rapidly.' The same point is reiterated again and again; it reappears, for example, in that stimulating and well-known book *Great Britain in the World Economy* (1946) by A. E. Kahn (p. 74). The unanimity of opinion is accentuated by the fact that now that economic historians have begun to take an interest in the period they have followed suit without deviation. In his *An Economic History of England 1870–1939* (1960), W. Ashworth argues (p. 335): 'What seems probable however is that, in the 'thirties, though many promising and profitable types of production were begun, a large proportion of them were not carried nearly as far as they might have been, or as far as they were in competing countries.' The other recent work by an economic historian on the period, A. J. Youngson's *The British Economy, 1920–57* (1960), throws little light on the problem at issue, although it contains comments on the new industries in the twenties (pp. 46–49) and the thirties (pp. 107–11). However, one clue which suggests that Professor Youngson perhaps shares the view that the new industries were not doing as well as they might is given when he describes the new industries in the thirties as 'uncertain and struggling' (p. 211).

The above list of authorities is an impressive one and the arguments which they use to support their view are superficially strong. Upon closer inspection, however, these arguments contain weaknesses; at this stage I will discuss only two.

Professor Ashworth (op. cit., p. 344) stated that Britain imported more of the newer type of goods (or of manufactures for which there was a growing world demand; which he is referring to is ambiguous) than she exported. Admittedly, he adds the qualification 'probably', but nevertheless the effect of this statement on someone seeking to denigrate the new industries is that it gives them another nail for the coffin. Yet Professor Ashworth does not elaborate on the products to which he is referring, nor does he support his claim with statistics. The table given below seeks to remedy this: it gives details of imports and exports for some products of the new industries in the thirties. It is easy to see that these

statistics contradict his argument; it would be interesting to know which goods he had in mind, for if his statement has any validity it can only be as the exception rather than the rule. It is evident from the table that the only products which are compatible with his statement are electronic valves and electric lamps—and those for volume only. If value is taken as the criterion the position is reversed, for the exports of both these products were far more valuable than imports. For other products conclusions are similar; for example, in the chemical fertilizer industry imports of superphosphates fell from 114,000 tons to 14,500 tons, 1931–8.[1] Of course there were a few speciality luxury goods to which Professor Ashworth's statement applies, such as watches. British production of watches was small before 1939, exports were negligible and most of the watches in use were imported from abroad. At best, however, the argument is misleading.

All the critics of the new industries stress their relative failure in exports. Moreover, they argue that in so far as they did export it was to a disproportionate extent confined to Commonwealth markets where trade received a stimulus from Imperial preference. The most extreme conclusion to be drawn from this is put forward by A. E. Kahn (op. cit., p. 107), who argues that there was 'no cause for this especially great dependence . . . upon relatively sheltered markets, except competitive weakness'.

The facts are not in doubt. In many cases the proportion of the new industries' exports going to the Commonwealth was three-quarters or more. But it is very naïve to postulate a causal relationship between this fact and the existence of Imperial preference. The argument that the orientation of the export markets for new products towards the Commonwealth was due to competitive weakness is completely unproven. There is indeed a far more feasible explanation. The new goods were in general expensive consumer and capital goods, such as motor-cars and electrical equipment, which are only of use to highly civilized and wealthy societies. Demand was consequently significant only in Western Europe and the United States where it could be satisfied by domestic industry and in the rich and rapidly developing primary-producing countries, pre-eminently in the British Dominions. Apart from these, there were no other countries with a level of income per head high enough to need these products in any quantity. Of the possible suppliers for the Dominions, moreover, Britain was the strongest candidate, for in return she constituted the greatest single market for primary products; it is a commonplace that factors favouring trade in one direction frequently favour trade in another. Thus it was quite logical that the British Dominions should provide the largest market for the exports of Britain's new industries.

[1] Monopolies Commission, *Report on the Supply of Chemical Fertilizers* (1959), p. 21.

TABLE I

Relation between Imports and Exports of the Products of some Newer Industries in the Thirties

Product	*Period*	*Imports* (annual average)		*Exports* (annual average)	
		Volume (nos.)	*Value* (£)	*Volume*	*Value*
Motor vehicles	1930–8	10,950	1,666,000	59,400	8,171,000
Pneumatic tires	1930–8	88,060	112,000	1,333,740	2,712,000
Electric lamps	1930–9	50,511,000	224,000	14,028,000	519,000
Insulated electric wires and cables	1930–8	..	479,000	..	2,908,000
Electronic valves	1930–9	1,860,400	216,000	1,292,900	388,000
Electrical machinery and plant	1930–8	..	383,000	..	3,678,000
Rayon piece goods	1933–8	25 million sq. yds.	..	64 million sq. yds.	..
Rayon yarn	1933–8	1·8 million lb.	..	9·5 million lb.	..
Staple fibre and rayon waste	1931–8	negligible	..	8 million lb.	..

Kahn's over-simplification of the question was probably due to an exaggeration of the importance of Imperial preference. His argument would only make sense if the new goods were subject to the ravages of competition in foreign markets but were immune from competition in the Commonwealth because of the security that Imperial preference gave them there. But this was by no means true, for Imperial preference sometimes proved of no avail when British exporters were faced with sales drives from their competitors in Commonwealth markets. Take the Austrialian market for motor vehicles, for example. During the world depression Britain was easily the largest supplier of motor-cars to Australia, but by the middle thirties the United States had taken over the lead; the result was that Britain's share of Australian car imports fell from 61 to 35 per cent., 1932–6. The point was that competition in the products of the new industries was at least a potential danger in Empire, Commonwealth, and foreign markets alike.

II

Those who have stressed the inferior position of the new industries of Britain relative to those in other countries with respect to technical performance have relied upon two types of evidence: comparative

productivity (especially Anglo-American) figures and facts indicating a more impressive rate of technological innovation abroad than at home. The reliability of the two will be discussed in turn.

This is no place to pay disrespect to L. Rostas's pioneering work, *Comparative Productivity in British and American Industry* (1948), but it is necessary to point out the limitations of such a study. Changes in productivity over time within a country (particularly within an industry) are far more valuable than comparisons of the productivity of industries at one point of time between countries. If productivity figures are used for the former modest purpose (once the difficulties of measurement have been surmounted), the record is impressive. The rise in output per wage-earner in British manufacturing between 1924 and 1937 was considerable, amounting to 37 per cent. In the new industries the increase was even greater: in the motor industry output per man-year doubled 1924–35, while in the rayon industry output doubled in the short period 1930–5 as a result of an increase of only 18 per cent. in the labour force.

On the other hand, productivity was low in relation to the position in the United States: in the inter-war years the compound annual rate of growth in productivity per man-hour in manufacturing in Britain was only 2·5 per cent., while in the United States the rate was 3·5 per cent. As for the new industries, in 1935 productivity in their motor industry was three times that of the British and in the radio industry four and a half times as large. But the question arises: are these comparisons meaningful? The dangers involved in the use of such statistics have been urged most cogently by W. E. G. Salter in a recent book, *Productivity and Technical Change* (1960).

His main point in this connexion is that if technical progress, and consequently productivity, were greater in the United States than in Britain, this did not imply that Britain was 'inefficient' or that her management in industry was inferior. For technical progress was more widespread in the United States because of the nature of the economic environment there as reflected in standards of obsolescence. In many industries the best plants in Britain compared well with those of the United States; the point was that there were more out-of-date plants in this country—and the explanation of this was not lack of entrepreneurial ability and foresight in Britain but the higher standard of obsolescence in the United States. Why was this standard higher in the United States? The answer is simple—the margin of obsolescence is determined by the level of real wages, that is, 'when labour is an expensive factor of production, an economy must adjust rapidly to new methods which require less labour' (p. 71). Thus the predominance of more efficient plants in the United States and the higher productivity may have been little more than

an inevitable consequence of the fact that the level of real wages there was far above that in Britain.

If this argument is sound, in those industries where technical factors necessitated a high ratio of capital to labour American productivity should not have been much greater. There was some evidence for this: in the rayon industry which was particularly capital-intensive the ratio of American to British productivity was only 1·5. The fact that productivity was still higher in the United States was to be explained by another inherent advantage she possessed—her large and stable home market. This meant that American industries were able to take especial advantage, *at an early stage*, of large-scale mass production and distribution methods. This leads on to another point made by Salter. Productivity in the British new industries was relatively low because, being 'new' and therefore of limited size, they had scarcely begun in the inter-war years to explore the possibilities of large-scale production (p. 134). He cites the case of turbo-generators in the electricity supply industry; the capacity of the first was only 1,000 kilowatts but by 1950 units of 200,000 kilowatts were in use. This is an adequate riposte to those who criticize the new industries on the ground that they did not expand quickly enough to absorb the excess labour force from the old staple industries. The growth of the motor and the electronics industries since 1945 illustrates the tendency of the new industries, with the passage of time, to expand continuously to new levels of production. This trend was observable even before 1939, for the development of the new industries was far more rapid in the thirties than in the twenties, and was comparable with growth abroad. Indeed, it has been shown in an important article, 'Investment in Industry—Has Britain lagged?', *The Banker*, April 1957, by T. Barna, that in the thirties output per head in British industry was increasing faster than in Germany (31 per cent., 1929–38 as against 12 per cent.) while in the United States output per head was stagnant. In view of the fact that the United States, at least, had had a good start in the new industries, these statistics are significant, for they suggest that Britain was rapidly catching up. It is considered that general evidence of this kind is more meaningful than comparisons of productivity between countries at the level of the individual industry.

It is obvious that without the new industries—motor-cars, rayon, household appliances, radio and electrical engineering, for example—the increase in productivity and real income would only have been very small compared with what was actually achieved in the inter-war period. It is important, therefore, to understand how the new industries were able to assert themselves in the economy. Salter presents the following analysis (pp. 148–51). As technology in the new industries improves, and as the

economies of scale are realized, their costs fall, and this makes for falling relative prices, rapidly expanding output, and increasing employment. This affects declining industries by means of both demand and cost pressures. The demand pressures operate via the price-reducing activities of the new industries; as the prices of new products fall declining industries are robbed of markets, for many of these products were adequate substitutes for old ones. The replacement of cotton fabrics by rayon and of gas and coal by electricity and oil are obvious examples. The cost pressures are most clearly visible in the case of labour costs, for as the new industries expand they require increasing numbers of workers to whom they are able to offer higher wages. This affects the general level of wages and the declining industries are also affected. The result of all this is to reinforce the decline of the old industries in total output.

It is only by understanding this—the nature of structural change in the economy—that the importance of the new industries in the inter-war years can be appreciated. The new industries are sometimes criticized because their increase in output and employment did not adequately compensate for the decline of the staple industries, but the criticism is hardly fair if it is based on the fact that the substitution of new industries for old was not completed in the inter-war period. This was not achieved by 1939 because of several factors: the old industries were predominantly export industries while the new tended to be home-market industries, and thus Britain was faced with the difficult and laborious problem of diverting a large part of her resources from manufacture for export to manufacture for home use; the sharp contrast in geographical location between the old industries and the new (that is, the old being heavily localized in the north while the new tended to sprout up in the Home Counties and the south) seriously aggravated the transfer problem, especially with regard to labour; the post-war boom of 1919–20 and certain external factors in the twenties masked the decline of the staple industries, and it was not generally realized until the next decade that the solution of Britain's difficulties did not lie in their recovery but in the reallocation of resources to the new. Those critics who point to the heavy unemployment of the thirties or to the small scale of the newer industries as an indication of their failure are drawing attention to irrelevancies. What is important is that the new industries were a potent force making for permanent structural change in British industry, and to place an arbitrary time-limit (such as 1939) for the readjustment to be made is to ignore the difficulties involved.

The admirable theoretical analysis of the relationship between productivity and technical change by Salter suggests that if one wishes to criticize the British industries' technical performance relative to those abroad one will have to find more reliable criteria of evidence than

comparative productivity statistics. It is necessary, therefore, to use other sources of information to inquire whether or not the rate of technical innovation in British new industries was low in relation to other countries. This, of course, has been done, but critics of Britain's progress have tended to ignore the evidence in favour of Britain's performance, although a mitigating factor is that most of this evidence is of very recent origin.

A common argument is that research expenditure in British industry was at a low level compared with that of the United States. This fact was pointed out more than 30 years ago by the Committee on Industry and Trade, *Factors in Industrial and Commercial Efficiency* (1927). In the period 1920–6, the research associations of the motor industry spent only £25,000, the rubber industry £28,000, and the electrical industry £50,000; whereas in the United States, in 1924 alone, the General Electric Co. spent $3 million, Du Pont $2 million, and General Motors $1 million (p. 319; pp. 333–4). Of course, this did not necessarily imply a low rate of technical innovation. Although the correlation between research expenditure and technical progress was probably positive, there may be some truth in the argument that the more money an organization has to spend the more it is likely to be squandered. It must also be remembered that the activities of the research associations of individual industries was not the only research under way. The government gave some direct encouragement through various channels: State-owned laboratories, development contracts given out to selected industries, its own manufacturing facilities. Most important of all was the private developmental research of the large firm.

The most quoted example of British failure and inadaptability in this century is the dyestuffs industry. Britain had failed to develop such an industry before the First World War, and although one was stimulated by government intervention in the inter-war period (that is, under the Dyestuffs (Import Regulation) Act of 1920) British backwardness persisted; even by 1937–8 Britain was a net importer of dyestuffs by value (though not by volume, since we exported 97,000 cwt. compared with an import of 45,000 cwt.).[1] But in other industries there was a completely different picture. For the radio industry S. G. Sturmey's *The Economic Development of Radio* (1958) is a testimony to the constant stream of innovations introduced in Britain. The industry took up many technical improvements in the inter-war years such as automatic volume control, press-button tuning, multiple wave bands, static reducing devices, and better calibration of dials; portable radio sets and car radios were on the market from 1933 (pp. 178–9). As a separately housed unit, the Rice-

[1] W. B. Reddaway, 'The Chemical Industry', in D. L. Burn, *The Structure of Industry*, vol. i (1958), p. 247.

Kellog moving coil loudspeaker was on the British market before it reached the American (p. 169). In an article in *Lloyds Bank Review*, October 1957, 'Science and Industry', T. Wilson points out the interesting fact that although the United States was ahead in the work on the television camera Britain had the first fully electronic television service in the world. Rapid technological change also showed itself in techniques of production: in the thirties most of the leading set makers adopted line production methods, in many cases with endless belt conveyors. On the debit side, Sturmey states that technical advance in receiving sets was faster in America before 1939, and that much of the progress recorded here was based on communicated American patents. This was also the case in several other related industries. For example, in the production of electric lamps although Britain was not responsible for any major development, leading British maufacturers were able to acquire United Kingdom patent rights under a series of agreements with the principal American and German companies; from 1912 British-Thomson-Houston, G.E.C., and Siemens had a patents pool. This method of taking up technical advances was not necessarily harmful, for the disadvantages of being the first with an innovation may in some cases outweigh the advantages. There was something to be said for letting other countries make the running and for us to follow, to profit from the mistakes of others and to avoid the risks of investment in research—in other words, to reverse our role of the Industrial Revolution and to allow other countries to pay the penalties of industrial pioneering. As Professor Ashworth reminds us, 'the adoption of technical advances which originated abroad would nevertheless increase the efficiency of production at home' (op cit., p. 415).

In other industries, too, Britain's performance seemed adequate. In the motor industry, the conclusion of the P.E.P.'s *Report on Motor Vehicles* (1950) is that technical development was largely confined to the post-1945 era (p. 55), but in fact there were continuous improvements in the inter-war period: better carburettors, more efficient brakes and combustion chambers, automatic voltage control in electrical equipment, thermostatic control of cooling systems, group lubrication, windscreen wipers, self-starters; besides the more obvious developments such as the diesel engine, pneumatic tires, and generally better coachwork design. In the plastics branch of the chemical industry, as a short but interesting article by P. Morgan, 'The Plastics Industry, 1958', *National Provincial Bank Review*, February 1958, reveals, there were significant technical advances in spite of the fact that the output of plastics was less than 30,000 tons in 1939. The use of cellulose acetate as an injection-moulding material began in the late twenties for producing thimbles, golf tees, and small radio components. Resin M (the forerunner of Perspex) was being

produced in the United Kingdom from 1937. In 1933 Britain was responsible for one development which today seems of almost revolutionary importance, the discovery of polythene by I.C.I.—just one of the many results of the research on polyvinyl compounds in the thirties; by 1939 the first polythene unit had begun production. Finally, in electricity, Britain was the first with the idea of electrical heating for public buildings.

On this question of the tempo of technical innovation there is a danger in assuming that the conditions operating before 1914 continued in the inter-war period. There is little doubt that in the quarter-century before 1914, as a generalization, the rate of technological change in Britain was slowing down—in some of the newer industries as well as in the old (although S. B. Saul in the article mentioned below warns against overestimating this). Take, for example, the following conclusion on the electric lamp industry: 'The British manufacturers of incandescent lamps had dropped far behind the Germans by 1900, as indeed had all the British electrical industries. . . . The obstacles . . . which largely persisted from 1897 to 1912 were apathy, limited ability and a lack of specialisation. . . . There was not a single lamp-research laboratory in Great Britain during all that time, and all important innovations were imported from Germany, Austria and the United States.'[1] It is very easy to extend this argument into the inter-war period, but it would be a false step of inquiry. In 1914 many countries of the world were enthusiastically expending the energies of industrial youth, while Britain appeared to be settling down to a restful and, perhaps, complacent middle age. Yet, did this necessarily mean that in the inter-war years she would announce her retirement?

To predict this from pre-1914 experience was to disregard the course of events. The First World War, of course, intervened and this proved a stimulus to rejuvenation. Whether the economic consequences of war are beneficial or not is still a matter for dispute, but it would be difficult to overlook the boost given by this war to the new industries. This is brought out in the famous article by R. S. Sayers, 'The Springs of Technical Progress, 1919–39', *Economic Journal*, June 1950. His view that the effect of the war was 'to accelerate rather than to innovate development' (p. 278) is probably substantially correct, but (as some of the following examples illustrate) is not applicable to every case. Moreover, the examples that Professor Sayers cites—the aircraft, the motor lorry, the rise of automatic welding and the development of certain plastics—are mainly the obvious ones. Large-scale production of valves grew up in response to the demands of the armed forces for large quantities for radio communication, and the commercial production of valves and radio sets was under

[1] A. A. Bright, *The Electric Lamp Industry: Technical Change and Economic Development from 1888 to 1947* (1949), pp. 161–2.

way as early as 1919–20. The development of cellulose acetate rayon, which by 1930 accounted for 20 per cent. of the world's rayon output, originated in research at a government factory during the war on the use of cellulose dopes for strengthening aircraft wings. It was the realization that dye-making plant is rapidly adaptable to the requirements of chemical warfare which induced the government to give a grant of £2 million for the development of the industry in 1918, and to pass legislation regulating imports in 1920. Similarly, military demand factors were at work in aluminium and alloys research, in insulated cable production and in petroleum chemistry.

The trouble with evidence of this kind, however, is that it is too general and unsystematic. It is very easy to answer an accusation of technical backwardness with an example of technical progress in another industry or even in the same industry. What is required is a more detailed examination of the many factors governing the rate of innovation in each industry. In a recent article, 'The American Impact upon British Industry, 1895–1914', *Business History*, December 1960, S. B. Saul examines the effect of American competition in stimulating individual firms in certain sections of the engineering industry to adopt technical improvements and to introduce innovations during the two decades before the First World War. Until we get more articles of this type on the new industries in the inter-war years, the problem of whether or not their rate of innovation was lower than it might have been is likely to receive no clear solution.

Another problem which deserves more attention is that posed by Salter (op. cit., p. 24) of how far the application of new techniques is due to the acquisition of new knowledge and how far it is attributable to changed factor prices. For if in certain industries Britain was behind in technical innovations in the inter-war period this was not necessarily a sign of lack of initiative, but could have been explained by the fact that it would have been uneconomical to introduce them. For example, because of the heavy unemployment on the one hand and the falling off in the rate of saving with a consequent scarcity of capital on the other, Britain's supplies of labour were plentiful relative to her supplies of investment and this militated against the rapid adoption of new techniques. Thus, *if* Britain was backward technically this may have been a reflection, not of the failure of applied science, but of the economic conditions of the time.

What we really need to know, of course, is how the many factors at issue affected the decisions of the individual entrepreneur. This can be observed not by referring to industries, but only by studying the individual firm—hence the importance of business histories. Two recent publications are concerned with new industries: J. D. Scott, *Siemen Brothers, 1858–1958: An Essay in the History of Industry* (1958), and C. Wilson

and W. Reader, *Men and Machines, A History of D. Napier and Sons, Engineers, Ltd., 1808–1958* (1958). Both shed light on how individual firms faced the problems of technological innovation.

Napier & Sons, by the first decade of this century, was a small specialist car firm. At the end of the First World War the firm realized that the future lay with moderately priced cars turned out by large manufacturers. The company therefore changed over to the production of aero engines; in 1919, 300 Lion engines were put into production in spite of the fact that there were no orders for them (pp. 110–11). This suggested that the outlook of the management (if foolhardy) was at least progressive. However, in the twenties the policy paid off; in the period 1924–35 73 types of British aircraft had Napier engines, and in 1928 and 1929 world air-speed records were set up with planes running on Napier engines. The firm did not figure prominently in the export trade, but there was a simple explanation for this—several of its engine designs were on the Secret List. On the other hand, the authors point out that although the firm was very progressive technically, it was not so commercially (p. 120). This distinction is of general importance. For it may possibly be argued that Britain's failings were not due to tardiness in the application of new techniques or in scientific research, but to conservatism in the commercial field. British businessmen tended to be sceptical about the value of market forecasting, paid insufficient attention to the diversity of the demands of consumers (especially those abroad), and relied on rule-of-thumb and outmoded methods in sales policies.

Siemens was a much larger firm, originating as cable-makers but later branching out into other sections of the electrical industry. By the middle thirties it was possible to speak of a team or even of a research and development organization consisting of a dozen or more workers at their branch in Preston (which specialized in lamp production). The firm represents an example of how a manufacturer can do well without making the basic innovations. In 1918 the British cable had a 'world-wide reputation' and was regarded as a sort of prize exhibit, yet all the important technical advances between the wars came from abroad. In spite of this, the methods adopted by Siemens, the leading firm, satisfied their customers. In the field of telephone cables, for example, the G.P.O. was satisfied with the 'minor improvements in the regularity of the product' (p. 139). In contrast with Napier, therefore, this firm was not very go-ahead in development, but the scale of development undertaken reflected the commercial needs of the time in the sense that their customers were content with it. If this was 'backwardness' it did not prevent Siemens from expanding their exports in the late thirties, when the general trend was for international trade to decline. Just as Napier & Sons extended the range of their

products by turning to aero engines, so Siemens in the years before the First World War began to manufacture electric locomotives, motors for rolling mills, batteries, telegraph and telephone line material, electrical machinery for use in ships, wireless telegraphy, 'fringe equipment' for the telephone industry, and lamps; the production of these was expanded considerably between the wars, especially in the case of automatic telephone exchanges and electric lamps (pp. 196–204). This willingness of firms to branch out into new lines was in fact typical of the new industries, and because it almost invariably involved new plant and sometimes new processes and techniques of production this characteristic indicates the progressive attitude of these industries towards technical change. In the twenties Dunlop experienced a similar widening of the scope of activities. In 1925 they turned to producing footwear, clothing, belting, and rubber hose; in the next decade other products involving the use of latex were added to their range.

The evidence given in these two histories suggests that it is dangerous to generalize about the technological bankruptcy of British industry. But two swallows do not make a summer, and far more business histories of a reputable standard are required before any firm conclusion may be drawn. The need for them is important, for the individual firm has been responsible for many, perhaps the majority of, technical developments. For example, Courtaulds, the rayon firm, undertook an intensive development of staple fibre in the inter-war period. This culminated in the thirties in the establishment of two experimental and demonstration mills the most important of which, the Arrow Mill at Rochdale, proved to Lancashire cotton manufacturers that staple fibre could be used extensively in Lancashire cotton mills. In the rubber industry, Dunlop's research was very successful: they were first in the field with aeroplane tires (1910), bullet-proof tires (1917), and giant pneumatic tires (1921). They had been the first to use carbon black in the tire tread, and in the inter-war years experimented in the use of rayon for casing.

III

An important source of material on the new industries for this period is the reports of the Monopolies and Restrictive Practices Commission (now the Monopolies Commission). Extensively used, of course, for investigation into monopoly problems, it is not often realized that they are a mine of information on the new industries, containing not only details of amalgamations and trade associations, but also general histories of the industries concerned and statistics of prices, output, and imports and exports. A list of the reports concerned with newer industries is given

below.[1] A large part of the information given in these reports is naturally about trade associations and amalgamation, and it is on these aspects that our attention will be concentrated.

In most cases the trade associations were formed in response to increasing foreign competition in the home market. The Tyre Manufacturers' Conference, set up in 1929, was an attempt to override the instability of trading conditions which had been a feature of the twenties. Its main purpose was to maintain prices, but it did not always succeed; in times of depression severe competition again became the rule, and company losses were great. The initiative in the Electric Lamp Manufacturers' Association, a reconstitution in 1933 of the former body of 1919, was taken by G.E.C. and A.E.I.; the members sought to meet by higher quality and by exclusive agreements with distributors the price competition of both imported, especially Japanese, lamps and lamps produced by independent British manufacturers. The B.V.A. (British Radio Valve Manufacturers' Association), constituted in 1926, also had to struggle to maintain agreed list prices in the face of vigorous competition from abroad. The Cable Makers' Association had been formed as early as 1899 with the aim of reducing costs of production by maximum efficiency. By 1931, however, the industry was bedevilled by excess capacity; the Association tried to meet this by promoting rationalization and amalgamation. The National Sulphuric Acid Association was established in 1919 to deal with surplus capacity of acid production, the result of enormous expansion during the First World War to cater for the needs of the explosives industry. Also in 1919 the Fertiliser Manufacturers' Association had been formed: its activities were extensive, including internal discussions on prices and attempts to counter the situation created by the sale of cheap foreign superphosphate in Britain. In 1921 the Association acquired a controlling interest in a Belgium company, Superphosphates Standaert, and agreements were made with foreign firms in Holland, Belgium, and France between 1923 and 1930, under which these firms consented to restrict their exports to the United Kingdom to agreed quotas. There was a severe depression in the production of metal windows in the early thirties, and attempts to standardize the commodity broke down. Consequently, the Metal Window Association was set up in 1933 and by 1939 had restored the industry to full prosperity; in 1937, for example, sales increased by

[1] In the electrical industries, *Report on the Supply of Electric Lamps* (1951), *Report on the Supply of Insulated Electric Wires and Cables* (1952), *Report on the Supply of Electronic Valves and Cathode Ray Tubes* (1956), and *Report on the Supply and Export of Electrical and Allied Machinery and Plant* (1957). In the pharmaceutical industry, *Report on the Supply of Insulin* (1952); in the chemical industry, *Report on the Supply of Certain Industrial and Medical Gases* (1956) and *Report on the Supply of Chemical Fertilizers* (1959); and in other industries, *Report on the Supply and Export of Pneumatic Tyres* (1955) and *Report on the Supply of Standard Metal Windows and Doors* (1956).

36 per cent. although the number of houses built increased by only 26 per cent.

The amalgamation movement was also widespread throughout the new industries. In the electrical industry (with particular reference to the valve section) Associated Electrical Industries was formed in 1928 and the company acquired all the ordinary shares of Edison, British-Thomson-Houston, and Metropolitan Vickers. This was partly responsible for the great extension of British valve production from 5½ million to 11 million, 1930–5. In the rubber tire industry Dunlop expanded rapidly during and after the First World War, mainly as a result of internal development rather than of absorption. After 1927, however, the firm followed a policy of controlling distributive outlets; for example, a majority interest was obtained in the firm of C. H. Brittain of Stoke. In 1938 the company began retreading with the acquisition of the Regent Tyre and Rubber Co. In the chemical fertilizer industry in 1928 I.C.I. gained control of a number of Scottish companies and in 1929 three East Anglian producers amalgamated to form Fisons; in the next ten years Fisons acquired twenty-four fertilizer companies and formed five new ones which were registered as subsidiaries. The British Oxygen Company absorbed its greatest rival, the Allen-Liversidge interests, in 1930, and thereafter followed a policy of acquisition at any cost. For example, it attempted to move into south-west England and South Wales by driving out and taking over the Cornish firm of T. W. Ward, Ltd., a manœuvre which was finally successful in 1944. Amalgamations and concentration were not, of course, limited to the new industries examined by the Monopolies Commission; other examples included Courtaulds in rayon, and Joseph Lucas and the Chloride Electrical Storage Company in the electrical equipment branch of the motor industry.

Although this trend towards monopoly and restrictive agreements could also be observed in the old staple industries, it was more prevalent in the new. The question arises whether the tendency to concentration in the new industries was due to the endogenous development of capitalism there or whether it was an exogenous effect of the prevailing economic situation during their period of growth, by which is meant the general depression of the inter-war years. While the depression undoubtedly presented a further incentive to cartelization, it seems clear that this grew up in the new industries out of their normal course of development. This is substantiated by the fact that in the post-war era of prosperity the trend continued and was intensified, except where and until the Monopolies Commission and the Restrictive Practices Court intervened. But history, too, suggests reasons why this was so. Kahn (op. cit., p. 81) contrasts the situation in the old industries, where the psychology was defensive, with

the new, where it was aggressive; in his view, the incentive to monopoly profits was strong simply because the new industries were not hampered by having developed into small, vigorously competing units. A. F. Lucas (in the standard work on industrial reorganization between the wars, *Industrial Reconstruction and the Control of Competition* (1937), p. 40) argues that the tendency for the new industries to locate themselves in the newer industrial areas of the south and the midlands struck a double blow at the competitive system. In the first place, it contributed to the general flux of industry which dislodged the British manufacturer from his old ways: secondly, it meant the rise of a group of new producers who were untarnished by the traditions of individualistic enterprise which had from the beginning characterized the staple industries. He concludes that it was this factor, above all, which led to the new industries' early denial of the philosophy of free competition. Both these arguments, while difficult to prove, seem plausible. Today, under the influence of the Restrictive Practices Act, it is too easy to condemn this trend towards monopoly and trade associations; but in the conditions of the inter-war period it was quite reasonable for one of the new industries' representatives to maintain: 'The day of the fixed price has come, and such a development must be considered as a real condition of social and economic progress.'[1]

The term 'fixed price' used in reference to the new industries between the wars may be misleading. Attempts to fix prices, whether by a monopolistic producer or a trade association, were made only at a given level of production—in other words, in the short run. In the longer run, the inter-war years witnessed a continuous reduction in price of all products of the new industries under the influence of technical progress and increasing economies of scale. The price index of motor-cars fell from 100 in 1913 to 51 in 1924 and 42 in 1936. In the electricity supply industry unit revenue derived by authorized undertakings from sales of energy to consumers was more than halved between 1921–2 and 1935–6. In the period 1923–38 the price of rayon viscose yarn fell from 9*s*. to 2*s*. 7½*d*. per lb., and in the thirties the price of viscose staple fibre fell from 3*s*. to 10*d*. per lb. The retail prices of electric filament lamps set by E.L.M.A. fell by about a third, 1930–8. In the pharmaceutical industry theprice of insulin fell from 25*s*. to 1*s*. 6*d*. for a standard pack between 1923 and 1935. Finally, in spite of the criticisms of B.O.C.'s price policies, the average price of industrial oxygen by 1939 was less than half what it had been at the outset of the inter-war period. In many cases these price reductions were achieved only at the expense of the profits of large firms and the livelihood of smaller ones. The solution to the paradox of price-fixing agreements

[1] British Electrical and Allied Manufacturers' Association, *Combines and Trusts in the Electrical Industry* (1930), p. 22.

and constant price reduction is as follows: the growth of industry is always governed by demand conditions, but in the newer industries where many of the products were 'high-income' goods the influence of demand conditions was even stronger because demand for these goods was very elastic; without technical efficiency and its result in the market, a long-term and significant fall in price, therefore, the new industries simply would not have expanded at all; on the other hand, manufacturers were anxious to maintain prices in the short run. Thus, the extensive price reductions in the new industries were not the consequence of depression but a necessary condition of growth.

Attention was drawn above to Saul's article which shows how American competition in the period before 1914 stimulated British industries to introduce innovations and adopt new methods. The process was taken a step further, particularly in the inter-war years, when Americans actually began to invest in British manufacturing industry and to establish subsidiaries here of firms in the United States. The details of this are told in J. H. Dunning, *American Investment in British Manufacturing Industry* (1958). What is really noticeable about this investment was its concentration on the new industries. In the motor industry Ford and Vauxhall, in tire production Goodyear and Firestone, in the electrical industry Associated Electrical Industries (in which the United States holding varied from 25 per cent. to 40 per cent.): these are obvious examples, but the range was wider. American investments in the United Kingdom were also in telephones, chemicals, gramophones, pharmaceutical products, machinery, and musical instruments. In the thirties American firms established branches in those newer industries in the development of which Britain was possibly falling behind, such as the Hoover Company (1931) in domestic electrical appliances and the Remington Rand Company (1937) in office equipment. Indeed, the United States was responsible for introducing many new methods and innovations into this country. The effect of the establishment of subsidiaries of Bristol Instruments Company in industrial instruments and of Frigidaire and York Shipley in refrigeration was to stimulate British firms to expand in the same field (p. 46).

What was the significance of this development? The impetus was strengthened by tariff protection, and United States subsidiaries were often intended as a means of surmounting tariff barriers. But the causes of the development are not so important as its consequences. Opposition was raised to American investment by firms in the electrical and rubber industries, and this was manifested in stipulations limiting American holdings of shares and voting rights. Yet United States investment in British industry did not necessarily imply a condemnation of British

industrial achievements and in fact had two important beneficial results. In the first place, American capital helped to utilize resources previously unemployed; 1919–39, 140 new enterprises were set up employing 60,000 workers (p. 298). Secondly, the fact that most of the American investment was in new industries and also contributed to the further expansion of British firms in these industries was a great advantage because it speeded up the adjustments in the structure of British industry necessary for highly industrialized countries, that is, the transition from old staple industries to the production of newer highly processed goods.

IV

Those who decry the role of the new industries in the inter-war economy stress their export position. Their argument is: first, that the new industries exported a far smaller proportion of their output than the older staple industries, and that this was an unhealthy development in view of Britain's overall balance of payments difficulties; secondly, that most of their exports went to protected Commonwealth markets; thirdly, that the new industries of Britain fared less well in the export markets than those of her competitors. Superficially, the factual basis in support of these arguments is strong, but there is a great danger in interpreting the meaning of these facts.

In the thirties 17 per cent. of the number of motor vehicles produced were exported; in rayon the proportion was smaller, 10 per cent. of yarn being exported and little more than 6 per cent. of piece goods; sales abroad in the electronics industry amounted to less than 10 per cent. of gross output. This formed a strong contrast with the staple industries, where in the most extreme case, cotton piece goods, almost 90 per cent. of output had been exported before 1913 and even in the thirties the percentage of production exported varied between 50 per cent. and 60 per cent. The proportion of output exported by the other staple industries was rather less but the contrast was still noticeable. There were a number of sensible reasons to account for this. The new industries, with huge resources of capital and technical knowledge, adopted the latest methods of large-scale organization and in fact spread round the world far more rapidly than had the old staple industries. This made for a more balanced distribution of new industrial production between countries, and consequently export markets were shared out more evenly. The prevalence of international agreements in these industries made direct inroads into exports, for a common feature in these agreements was the promise to 'reserve' to each member his home market. Moreover, as I. Svennilson points out in *Growth and Stagnation in the European Economy* (1954), the main developments of the period affecting manufacturing were domestic (p. 220). The

development of electric power, the extension of the use of motor vehicles and increased town and surburban building were greater demand forces on the new industries than any operating abroad. Another point was that Britain shared in the common objective at this time—what Svennilson calls a 'self-sufficiency boom': in face of falling exports, the accepted policy was to increase tariff protection and attempt to reduce the volume of imported manufactures. In such an international atmosphere the new industries were bound to look more to the home market, just as in the nineteenth century the staple industries, favoured by an insatiable world demand, had expanded mainly by catering for markets overseas. Indeed, it is possible to argue that the home-market orientation of the new industries was a source of stability in a period of declining international trade. Finally, to blame the new industries for the balance of payments difficulties of the inter-war years is a distortion of the facts. The problem of the twenties was largely the result of Britain's attempt to retain her position as the world's leading creditor by lending abroad, and when the balance of payments again became negative after 1935 the main factor responsible was increased imports in response to rearmament demand.

The second point of issue, that of the concentration of the new industries' exports upon Commonwealth markets, has been discussed earlier in this article. One observation only will be made here. It is easy to exaggerate the extent of this concentration if certain industries alone are chosen for illustration. In the motor industry, for example, of sales abroad during the inter-war period (apart from during the depression when Empire purchasing power was severely reduced) about 85 per cent. went to the Commonwealth. But taking the new industries as a whole (Kahn's classification) only 54·5 per cent. of their exports in 1929 went to the Commonwealth, and it is likely that this was increased only slightly as a result of the Ottawa agreements. Moreover, it must be remembered that a high proportion (about 40 per cent. in 1929) of staple exports went to the Commonwealth too.

The real attack on the export capabilities of Britain's new industries has been made in relation to their counterparts abroad and in the light of the changing structure of world trade. The best-known example of British deficiency in this respect is that illustrated by a German inquiry (*Der Deutsche Aussenhandel unter der Einwirkung weltwirtschaftlicher Strukturwandlungen* (1932), vol. ii, p. 156, quoted widely by E. Staley, *World Economic Development* (1944), A. J. Brown, *Applied Economics* (1947), W. A. Lewis, 'The Prospect before Us', *Manchester School*, May 1948, and G. C. Allen, op. cit.). This shows that, of a sample covering 80 per cent. of British exports (by commodities), 42 per cent. of our exports in 1929 were of goods which had increased less than 75 per cent., 1913–29,

while only 4·3 per cent. were of goods in which world trade had increased more than 150 per cent.; in contrast, 28·6 per cent. of United States exports were in the latter category. A. Loveday (op. cit.) draws similar conclusions from the new industries' performance in export markets in the twenties. In the period 1925–8 the Netherlands increased her exports of wireless apparatus by £1¾ million, whereas British exports declined; in gramophones and records, while British exports increased from £1·44 million to £2·78 million, United States exports soared from £830,000 to £2·26 million (pp. 168–70). These statistics are of doubtful value for 4 years is too short a time for any trends to emerge. More important is the conclusion of the British Economic Mission to the Argentine (quoted by Loveday) that while Britain held on to her position in certain trades, in the new departments of trade—for example, aviation, road construction, and motor transport—she had been completely outdistanced. It is probable, however, that all this evidence relating to the twenties has been given more attention than it deserves. If the new industries were still infant industries in the inter-war period, as is suggested here, it may be conceded that their development in the twenties was slow and argued instead that their achievements between the wars were centred in the thirties. That their export performance by 1929 was limited was only to be expected.

Of more relevance to this question are the statistics given by Svennilson and by H. Tyszinski, 'World Trade in Manufactured Commodities, 1899–1950', *Manchester School*, September 1951, especially as they cover a wider period. Tyszinski points out that Britain's share of world trade in manufactures fell from 29·9 per cent. in 1913 to 22·4 per cent. in 1937, and argues that because this fall would not have been as great if Britain had kept the same proportion of her exports in the old staple industries throughout this period the cause of the decline was not so much changes in the structure of world trade but in her capacity to compete. The indictment is not as well founded as appears on first sight, for in reference to the structure of trade the proportion of British trade in the expanding groups increased from 17·7 per cent. to 31·2 per cent., 1899–1937, while world trade in this group increased from 13·4 per cent. to 34·8 per cent. (pp. 289–92). Thus, in spite of losses in her competitive position Britain did not lag behind the shifts in the structure of world trade to any great extent. This is supported by similar evidence in Svennilson (op. cit., tables, pp. 294–5). He shows that the categories 'Machinery' and 'Transport Equipment' were the expanding ones in world trade. The share of these in British exports increased from 15·9 per cent. in 1913 to 19·5 per cent. in 1928 and 31·6 per cent. in 1938 at the expense of textiles, which fell from 48·2 per cent. to 44·9 per cent. and 28·5 per cent. of exports at the above respective dates—and this change signified a successful adjustment

in the structure of Britain's export trade. A. J. Brown in *Industrialization and Trade: The Changing World Pattern and the Position of Britain* (1943) presented statistics showing that the exports of machinery, electrical appliances, vehicles, and chemicals increased in relation to total exports from 14 per cent. to 40 per cent., 1910–38 (p. 60). What are the implications of this? In the first place, the argument that Britain failed to compensate for the fall in staple exports by the expansion of exports of the newer industries is overstated. Secondly, the cause of Britain's decline in world trade and her *apparent* sluggishness in exporting new products in relation to her best competitors and her former predominant station is to be found in her competitive position; by this one means not an absolute deterioration in the power of individual industries to compete effectively in world markets, but a change in international economic relationships unfavourable to Britain consequent upon the industrialization of new countries and the appearance of new competitors. She was no longer a giant among pygmies, but one of many. This did not mean failure, only the inevitable adjustment of British industry to its proper place in the modern world.

In fact, in certain of the new industries Britain was keeping in advance of their importance in world trade. In transport equipment (including motor vehicles) British exports expanded from £7·6 million in 1913 to £29·6 million in 1937, while its share in world trade rose from 3·3 per cent. to only 9·4 per cent. in the same period; similarly for electrical goods Britain's exports rose from £7·7 million to £19·1 million in the same period while the share of electrical goods in world trade increased from 2·4 per cent. to 4·7 per cent. (Tyszinski, loc. cit, pp. 278–83).

The argument that Britain was falling further and further behind in the development of the new industries, particularly with regard to overseas trade, makes nonsense when one looks at their post-war position. For example, by 1956 50 per cent. of the output of motor-cars were exported and the proportion of production sent abroad in electronics rose from 8 per cent. to 15 per cent., 1938–56. Although it was probable that conditions after the Second World War were especially favourable for British exports of those products, nevertheless, this dramatic transformation does not tally with the usual interpretation of the new industries' experience between the wars.

If Britain appeared to be lagging slightly behind, a possible explanation is that the new industries were infant industries in the inter-war years, and that this lag was merely a symptom of growing pains. That the government regarded them as such is suggested by the fact that almost all the new industries had received some form of tariff protection before the fundamental change in British commercial policy. The adjustment

was slow but, as the post-war record shows, successful. The reasons for the slow pace of development are easy to find. Britain had come to world supremacy as the producer of common consumer goods. The products of the new industries were of a different nature—usually either equipment for production and communications such as machinery, cars, and communication devices or 'high-income' goods such as radios and gramophones. These were mainly capital goods industries, and it was more difficult for Britain to make the change. Britain also suffered from a lack of the increasingly important cheap hydro-electric power, petroleum, and non-ferrous metals. The United States, on the other hand, was better equipped because of an environment which made for the smooth application of a rapidly progressing technology to industry and because of a highly developed home market which encouraged methods of quantity production at low unit cost. Svennilson makes an important point which throws light on Britain's slow adjustment when he suggests (p. 116) that the prevalence of industrial areas 'based on the direct use of coal, coke and gas' delayed the extension of electric power on which successful production in many of the new industries depended. Another factor of significance (table, p. 241) is that Britain was the most industrialized country, 90 per cent. of the occupied population in 1920 being employed outside agriculture, as against 58·3 per cent. for Europe as a whole. This perhaps made the transition more difficult for Britain, for it is a reasonable hypothesis that the labour transfer problem between old industries and new is aggravated the higher the proportion of manpower already committed to the old manufacturing industries and is alleviated when semi-skilled workers for the new may be recruited from agriculture.

One final point—was it necessarily a criticism of the new industries that their export position was not as strong as that of her best competitors abroad? It is too readily assumed that exports are the sole criterion of industrial achievement. Keynes once said that he saw no special virtue in exports for their own sake which were not required to pay for imports. As A. J. Brown points out (*Industrialization and Trade*, p. 64) exports are not so important if imported goods, for which adequate substitutes can be produced at home at little more than the import prices, are replaced by home-produced goods, in such groups as iron and steel goods, cutlery, instruments, machinery, vehicles, and electrical goods. In fact, in the inter-war period the imports of these goods tended to fall as home production of them increased. Moreover, as Professor Ashworth suggests (op. cit., p. 322), the new products were far more highly processed than the old and consequently the imports of raw materials were likely to grow less proportionately than the production of new goods, and there was thus possibly less need for expansion in exports.

Indeed, the case that the new industries should have exported more than they did between the wars has never been proved.

V

This article in its assessment of recent evidence on the new industries has been able to concentrate on only a few aspects of their development. The solutions offered to the problems raised have not been conclusive; what has been demonstrated, it is hoped, is that the traditional view has been too easily accepted. To take a low view of the new industries' position was possible 20 or 30 years ago under the shadow of unemployment and general depression, but it is scarcely feasible in 1961 now that these former 'new' industries have developed into the staple industries of modern Britain. Because a larger proportion of her resources was involved in the old basic industries of the nineteenth century, Britain's newer industries were later in maturing than those of, say, the United States. It is quite possible, therefore, that even in the inter-war period these industries were still fundamentally infant industries which had not yet benefited from full economies of scale, and on this view the difficulties they incurred can be passed off as inevitable teething troubles. This interpretation, simple though it may be, at least allows one to make sense of the inter-war and post-war experience taken together.

There are a number of unsolved questions hardly touched upon here which will have to be answered before a complete assessment of the new industries' place in the inter-war economy can be made. Did the protection of the new industries act as a deterrent (or perhaps as a stimulus) to technological advance? How great a handicap on the shift to new industries was the fact that Britain was more deeply involved in the fortunes of the old staple industries than her competitors? Was government intervention an obstacle or an aid to development; in other words, did the benefits of tariff protection and the extensive influence of public corporations on certain of the new industries outweigh the restrictions on road transport, the deadweight of the tax-licensing system for motor vehicles and the burden on small producers of the excise duty on rayon yarn? How far did the misplaced faith in the capacity of the old industries to revive in the twenties delay investment in the new? In view of the fact that the new industries generally had a high ratio of capital to labour, was the heavy unemployment of the inter-war years a factor limiting their expansion—because some of the older industries employed more workers per unit of capital invested? As there were obvious links between the new industries (motor-cars and rubber tires, motor-cars and electrical equipment, plastics and radio parts, rayon and chemicals), how far was the fate of one industry bound up with that of another? Most important of

all perhaps, what effect did the Second World War have on the new industries, and how many of the elements in their post-war expansion could be discerned before 1939? The answers to these questions may well be different for each industry. There is no *a priori* reason why all the new industries should have done well, or all done badly. Indeed, it is more likely that their fortunes were varied and their expansion was uneven. What is maintained here, however, is that if a generalization must be made on the state of Britain's new industries between the wars, the judgement which maintains that they were doing as well as might be expected and were fighting to hold a respectable position in a competitive world is far more realistic and plausible than that which holds that they were falling behind.

University of Aberdeen.

APPENDIX

A SELECT bibliography of works not discussed or mentioned in the text is given below. All the official publications in this list are important, but the rest of the material is not of uniform value. Some works are mainly about post-war developments and the inter-war years receives incidental mention only; others are not directly concerned with the new industries yet contain useful information on them. Those books and articles which are considered of especial importance are marked with an asterisk.*

(i) *Official publications*

Standing Committee on Trusts, Sub-committee, *Report on the Electric Lamp Industry* (Cmd. 622, 1920).

Standing Committee on Trusts, Sub-committee, *Report on the Electrical Cable Industry* (Cmd. 1332, 1921).

Committee on Industry and Trade, *Survey of Textile Industries* (1928).

Committee on Industry and Trade, *Survey of Metal Industries* (1928).

Report of the Dyestuffs Industry Development Committee on the Present Position and Development of the Dyestuffs Manufacturing Industry in Great Britain (Cmd. 3658, 1930).

Third Report of the Dyestuffs Industry Development Committee (Cmd. 4191, 1932).

Annual *Reports of the Department of Scientific and Industrial Research.*

Imperial Economic Committee, 30th Report, *Survey of the Trade in Motor Vehicles* (1937).

(ii) *Books*

D. L. BURN (ed.), *The Structure of British Industry* (1958), 2 vols.*

J. H. DUNNING and C. J. THOMAS, *British Industry: Change and Development in the Twentieth Century* (1961).*

D. C. HAGUE, *The Economics of Man-Made Fibres* (1957).

W. G. HOFFMANN, *British Industry, 1700–1950* (1955).*

J. M. LETICHE, *Balance of Payments and Economic Growth* (1959).

G. MAXCY and A. SILBERSTON, *The Motor Industry* (1959).*

C. L. MOWAT, *Britain between the Wars* (1956).

National Institute of Economic and Social Research, *Trade Regulations and Commercial Policy of the United Kingdom* (1943).

A. PLUMMER, *International Combines in Modern Industry* (1934).
—— *New British Industries in the Twentieth Century* (1937).*
Political and Economic Planning, *Report on the Market for Household Appliances* (1945).
H. A. SILVERMAN, *Studies in Industrial Organization* (1946), 'The Artificial Textile Industry'.*
D. H. SMITH, *Industries of Greater London* (1933).
Society of Motor Manufacturers and Traders, *The Motor Industry of Great Britain* (1939).*
C. H. WARD-JACKSON, *A History of Courtaulds* (1941).

(iii) *Articles*

G. C. ALLEN, 'The Outlook for British Industry', *Westminster Bank Review*, August 1952.
G. R. ALLEN, 'The Growth of Industry on Trading Estates, 1920–39, with special reference to Slough Trading Estate', *Oxford Economic Papers*, October 1951.
A. K. CAIRNCROSS and R. L. MEIER, 'New Industries and Economic Development in Scotland', *Three Banks Review*, June 1952.
J. H. DUNNING, 'Newer British Industries and Increasing Productivity', *District Bank Review*, June 1954.
—— 'The Radio and T.V. Industry: A Post-War Survey', *Three Banks Review*, June 1952.
D. DUXBURY, 'The Role of Man-Made Fibres', *District Bank Review*, March 1957.*
D. W. HILL, 'Man-Made Fibres', *Three Banks Review*, December 1953.
R. HOPE, 'Profits in British Industry from 1924 to 1935', *Oxford Economic Papers*, June 1949.
E. J. JONES, 'Price Leadership in the Rayon Industry', *Manchester School*, vol. xii, 1941.*
C. E. V. LESER, 'Scottish Industries during the Inter-war Period', *Manchester School*, vol. xviii, 1950.
'Oil Refining in Great Britain: A Major New Industry', *Midland Bank Review*, February 1955.
E. H. PHELPS BROWN and S. J. HANDFIELD-JONES, 'The Climacteric of the 1890s', *Oxford Economic Papers*, October 1952.
Planning, 5 Dec. 1947, 'The Agricultural Machinery Industry'.
Planning, 2 July 1948, 'The Motor Industry'.*
Planning, 20 Dec. 1948, 'The Machine Tool Industry'.
Planning, 28 Feb. 1949, 'Commercial Vehicles'.*
Planning, 17 Oct. 1949, 'The Cycle Industry'.*
Planning, 5 Nov. 1951, 'The Gramophone Record'.
G. RAE, 'The Statistics of the Rubber Industry', *Journal of the Royal Statistical Society*, vol. ci, 1938.*
J. M. A. SMITH, 'The British Motor Industry', *National Provincial Bank Review*, May 1958.
W. WOODRUFF, 'Growth of the Rubber Industry of Great Britain and the United States', *Journal of Economic History*, vol. xv, 1955.*
Articles in *The Economist*, particularly:
'The British Motor Industry, I', vol. cxvii, 1933.
'The British Motor Industry', vol. cxxi, 1935, pp. 1129–54.*
'The Electrical Equipment Industry', vol. cxxvii, 1937.
and in *The Statist*:
'The British Electrical Industries', Supplement, 17 Dec. 1938.*

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